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A Review of Selected Problems of Tularemia

in the Soviet Union

by

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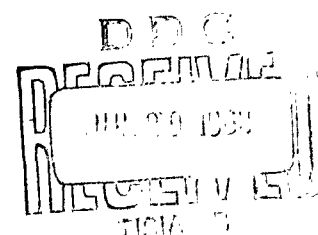
Part I

History and Recent Incidence of the Disease

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The present part of the tularemia report deals firstly with the evidence for the early existence of the infection in Russia and then in a detailed manner with the incidence of the disease during the four successive periods from 1926-1930, 1931-1940, 1941-1949 and 1950 to the present.

Brief attention has been paid also to the progress of tularemia research in the Soviet Union. The essential facts of the ecology of the disease have been referred to in the last section (period from 1950 onwards).

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### Summary

Though definite proof for the existence of tularemia in the Soviet Union has been obtained only in 1926, there can be no doubt that the disease existed there since time immemorial, acting then as now as one of the most important factors regulating the population dynamics of the rodent hosts of the infection. In fact, retrospective studies undertaken since 1926 have furnished more or less definite evidence for the early occurrence of tularemia manifestations. Thus it is most probable that, though misdiagnosed as benign anthrax, the disease was frequent since the 18th century at least in Western Siberia, an area identified afterwards as a hotbed of the infection. In another notorious focus, the Astrakhan Raion, the occurrence of an epidemic corresponding in all its features to a tularemia outbreak has been recorded in 1877 and similar manifestations have been observed from 1877-1879 in other parts of Russia including the Kazan Raion. Moreover, as has been pointed out with great reason, the wide distribution of tularemia in the Soviet Union noted during the years immediately following its discovery in 1926 forms a convincing argument against a recent appearance of this disease.

Reviewing the history of tularemia in the Soviet Union since 1926, one may distinguish four periods, lasting respectively from 1926 to 1930, from 1930 to 1940, from 1941 to 1949 and from 1950 to the present. The events characterizing these successive phases may thus be briefly described:

Period from 1926-1930. Conditions for a discovery of tularemia early in this period were particularly favorable because (a) hunting of water-rats, the main reservoir of the infection in a major part of the Soviet Union, which had been hardly done until then, was suddenly started on a large scale; (b) owing to one of the periodical population increases of these animals tularemia had become rampant among them; and (c) the establishment of an excellent anti-plague institute in Saratov had created good facilities for the investigation of zoonoses. Meeting with an outbreak causally related to an epizootic among water-rats in the Astrakhan Raion in 1926, the qualified workers of this institute recognized that they were dealing with a disease sui generis which they tentatively identified as tularemia. Manifestations of the same kind were observed in rapid succession in other parts of the Soviet Union, including besides the Volga basin also those of the Ural, Ob' and Lena rivers; continued laboratory studies definitely established the identity of these outbreaks with those of tularemia in the

United States. Routine methods for the laboratory diagnosis of the infection were soon adopted by the Soviet workers and tentative use was made of allergic tests in order to arrive at an early bedside diagnosis of the disease. It was established that besides the water-rats other rodents, particularly the common mice and voles could function as tularemia reservoirs and that blood-sucking diptera were apt to be the vectors of the infection.

Period from 1931-1940. Tularemia outbreaks not only continued to be frequent in the areas found hitherto affected, but were also noted in localities where the presence of the disease had not been observed thus far, for instance the Rostov Oblast, the Ukraine and the Buriat-Mongol Republic, where muskrats had become the reservoir of the infection.

Great progress was made during this period in tularemia research. Mention has to be made in this respect in the first line of studies on the immunology of the infection by El'bert and Gaiskii which laid the foundation for an efficient method of vaccine prophylaxis. Ecological studies also yielded results of great practical importance. The frequent conveyance of the infection through blood-sucking diptera (including horseflies) was confirmed through numerous observations and the most important role of various species of ixodes ticks not only as vectors but also as reservoirs of tularemia was recognized. Proof was likewise obtained for the frequent occurrence of outbreaks due to the use of water which had become contaminated in various ways during tularemia epizootics.

Period from 1941-1949. During the period from 1941-1949, i.e. the time of World War II and the years immediately following it, a most ominous increase in the incidence of tularemia took place. Particularly massive epizootics, followed by correspondingly large epidemics, occurred in the territories temporarily occupied by the German armies, like the Ukraine and the Stalingrad and Rostov oblasts, and also in other areas of the European part of the Soviet Union, where the interruption of agricultural operations and the suspension of anti-rodent campaigns had created extraordinarily favorable conditions for a mass multiplication of the mice and voles. The contending armies were also seriously involved. To judge from the statistics available for

a few limited areas, the total incidence of tularemia in the Soviet Union during the war years must have amounted to many thousands of cases.

Rather scanty information for the years immediately following the war indicates that after an initial decrease in the incidence of the disease the infection again gained great impetus in 1948 and 1949. Particularly massive outbreaks took place at that time in the Ukraine and in Moldavia. In Western Siberia, where the tularemia incidence seems to have been not unusually high during the war years, a great increase of the water-rat populations led to massive and widespread epizootics among these animals followed in due sequence by correspondingly serious manifestations of the disease in man.

It is consoling to note that during this period of a dismally high tularemia incidence great progress was made in the study of this infection. The most outstanding result of these investigations was the introduction of an effective system of anti-tularemia vaccination through Gaiskii, El'bert and some other workers. It was not possible to take full advantage of this prophylactic method immediately but, as illustrated for instance by the results obtained with it in the Volga-Akhtuba lowlands, its use was apt to lead to outstanding success.

Period from 1950 to the present. The present tularemia situation is described in the 1960 standard work edited by Olsuf'ev and Rudnev, according to which this disease is met with in all but four of the fifteen republics forming the Soviet Union. Foci of the infection thus continue to be present from the western border areas of the Union as far east as Iakutia and the recently affected Khabarovsk Krai and from the northern regions partly beyond the polar circle to the Crimea, the Transcaucasus and some republics of Central Asia in the south.

However, while in the past the presence of tularemia enzootics or epizootics almost invariably led to manifestations of the disease in man, it has now become possible to prevent such a transition of the infection through the implementation of prophylactic measures, in the first line through wholesale anti-tularemia vaccination.

A REVIEW OF SELECTED PROBLEMS OF TULAREMIA IN THE SOVIET UNION

I. History and recent incidence of the disease

1. History of tularemia up to 1926

Dealing with the history of tularemia in the Soviet Union in an article appearing in 1948, which he afterwards elaborated in his book on the Prirodnye ochagi tulariemii v SSSR ('Natural Foci of Tularemia in the Soviet Union'), Moscow-Leningrad, 1960, Maksimov aptly quoted the felicitous statement of Pavlovskii (1946) that

"diseases entrenched in natural foci<sup>1</sup> are old in nature and 'new' only in relation to the time and conditions of their appearance in man and still more 'new,' when one considers the time at which the physicians learnt rightly to discern them."

In full agreement with this dictum, Maksimov entertained no doubt that tularemia existed in the Soviet Union since immemorial times,

"its evolution probably taking place in close relation or in a parallel manner with the evolution of the mouse species of rodents. This infection undoubtedly existed since long ago as one of the important factors regulating the dynamics of the numbers of these species."

Maksimov pointed out in this connection that, as noted by Nekipelov (1944), an indirect proof for the old age of tularemia was its wide distribution. In the Soviet Union manifestations of this disease had been met with from Belorussia and the Ukraine in the west to the Iakutsk Republic in the east, and from the Transcaucasus in the south to the Karelian-Finnish Republic and the Leningrad Oblast in the north.

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1. Pavlovskii actually used the expression "bolezni s prirodnoi ochagovost'iu" which literally translated would mean "diseases with a natural focality." The term "focality" (in German Fokalität) is frowned upon by purists, because not in the dictionary, but recommends itself for the sake of brevity, particularly in order to avoid clumsy transliterations in the translation of titles.



## Tularemia-2

Retrospective studies, undertaken since definite proof for the existence of tularemia in the Soviet Union had been obtained, also furnished evidence for the early presence of the disease. This seems to hold true in the first line for Western Siberia, afterwards identified as one of the strongholds of the infection. There the wide spread and frequency of affections labelled as anthrax (significantly called Sibirskaja iazva, i.e. Siberian ulcer) had been noted by many travellers, first (according to Maksimov, 1960) by S. G. Gmelin in 1741. Scrutinizing these early records, Maksimov stressed that these manifestations had been met with at the seasons characteristic for vector-borne tularemia and in localities afterwards found affected by this disease. Of great importance also was the fact that, in contrast to what is the case in true anthrax, the mortality from the Siberian ulcer was low. Thus Middendorf (1869, 1871) reported that even in the worst-stricken localities usually the mortality from "anthrax" was not higher than 2 percent. For all these reasons one must certainly agree with Maksimov that

"an acquaintance with the historical materials on the outbreaks of Siberian ulcer in Western Siberia in the 18th and 19th centuries permits the assertion that besides with true anthrax one had to do also with tularemia."

This opinion has been shared by Olsuf'ev and Rudnev who in their authoritative text book on tularemia (1960), quoting besides earlier publications a 1959 study by Maksimov, made the following statement:

"On the massive spread of the 'Siberian ulcer' in many raions of the West-Siberian lowlands and the connection of this disease with a transmission by blood-sucking diptera wrote many travellers visiting these areas in the 18th and 19th centuries (I. Fal'k, A. F. Middendorf and others). It deserves attention that the local population considered the water-rats and hares as 'unclean' animals and did not hunt them.<sup>1</sup> The designation 'Siberian ulcer' points to a typical appearance of an ulcerative process in this affection which, in the case of

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1. Apparently, however, local exceptions from this rule existed - see Poliakov (1877) quoted by Maksimov (1960).

an infection by the cutaneous route, is equally peculiar for anthrax and for tularemia. It is known that in Western Siberia cases of vector-borne tularemia in man are observed much more frequently than such of vector-borne anthrax and that particularly for the vast marshy plains of Western Siberia, abounding in blood-sucking diptera, vector-borne tularemia outbreaks are rather characteristic."

The occurrence of individual outbreaks suggestive of tularemia during the half-century preceding the confirmed presence of this disease in the Soviet Union has been postulated by several authors, first apparently by Suvorov and his associates (1928) who concluded their description of a proven outbreak of the affection in the Astrakhan Raion in 1926 (see below) by stating that

"in the literature of the Astrakhan Krai there exist descriptions of analogous affections: thus in the publication of Galanin (Bubonic plague, 1897, p. 95) under the heading "Affections suspicious for plague in villages south of Astrakhan" are registered up to 200 attacks ending in recovery."

Recording this incidence, Galanin stated in his text that

"the predominating number of an affection of the cervical and submaxillary lymph nodes among the patients receiving ambulatory treatment and repeated references to an involvement of the tonsils leads to the belief that this figure includes cases which had nothing to do with the disease in question...."

Wisely he concluded, however, that

"in any case there remains the undoubted fact (of the occurrence) within a short time (of a considerable outbreak) of a peculiar disease, regarding the nature of which no exact conclusion may be reached."

The association of tonsillar affections with a disease generally involving the external lymph nodes makes it, however, practically certain that this outbreak, taking place during the period from 26 June to the end of August 1877, was one of tularemia.

#### Tularemia-4

Following the description of this epidemic Galanin recorded that manifestations of a similar kind had been observed during the period from 1877 to 1879 also in the Nizhnegorodski, Riazansk and Tavrichev governments as well as in Odessa and St. Petersburg. Moreover, the simultaneous occurrence of bubonic affections in a village of the Kazan Raion was reported by Godnev (1879).

Dealing with the observations in point made in St. Petersburg, Khodukin (1951) stated that one of the patients was demonstrated by Botkin who came to the conclusion that this man suffered not from plague but from a plague-like disease. Hence Khodukin felt entitled to assert that

"summarizing all what has been said above, we have full grounds to conclude that long before the foreign observers tularemia was described by our Russian scientists and first, (because) giving a classical description of this disease, one has to consider our great clinician S. P. Botkin...."

For an evaluation of this claim it suffices to state that, as testified by Galanin and recently by Olsuf'ev and Rudnev, Botkin considered his patient as suspicious for plague what caused an acrimonious polemic at the time. Claims that he might have suffered from tularemia were naturally made only after the existence of the disease in the Soviet Union had been confirmed, first apparently by Pletnev (1932).

Generally speaking Olsuf'ev and Rudnev warned against a rash identification of the bubonic affections described in the past with tularemia, pointing out with great reason that affections of the lymph nodes, characterized by a benign course and the absence of contagiousity could be the result of various infections such as listeriosis and tuberculosis. Hence these two authors doubted that the outbreak observed in 1825 in the Volynsk government by the military surgeon Chernobaev was one of tularemia, as had been claimed by Pokrovskaia (1940). Olsuf'ev and Rudnev entertained also some doubts regarding the 1884 outbreak in the garrison of Merv (now Mary) in the Turkmenian SSR, described in 1886 by Voskresenskii and suspected as a manifestation of tularemia by Khodukin (1951). The reason for doubt was that no further manifestations of the disease had been recorded in that area. However, Olsuf'ev and Rudnev admitted, that the Tashauz Raion of Turkmenia was found to be affected by tularemia.

There can be hardly any doubt that the major outbreak of "epidemic polyadenitis" observed by Anishchenko (1922) during the summer of 1921 in some villages on the Ob' River near the mouth of the Irtysh was one of tularemia. The disease was rampant

## Tularemia-5

among the people engaged in harvesting hay, about one quarter to one third of the population becoming infected (Roubakine, 1930). Out of 36 patients who could be examined, most (29) had cervical buboes. As summarized by Maksimov (1960), Anishchenko was at a loss to establish the cause of the outbreak. He refuted the idea of a role of blood-sucking insects. Nevertheless Maksimov was certainly right when asserting that this, like most of the above described outbreaks, was one of vector-borne tularemia.

Evidence for the early presence of tularemia in the Voronezh Oblast, situated in the central European part of the Soviet Union has been adduced by Sil'chenko (1952, 1955). He (1952) referred in this connection to suggestive manifestations in the Borisoglebski Uezd (subdistrict) in 1921-1922 and even claimed (1955) that tularemia had been active in the oblast since 1890. An outbreak of "epidemic lymphadenitis" in villages of the Ostrogozhski Uezd of the same oblast during July and August 1925 was recorded by Dederer (1929).

As maintained by Zil'fian (1958) attacks of a disease resembling tularemia had been observed in Armenia during the period from 1921-1924.

### 2. Period from 1926 - 1930

That during the period now under review the existence of tularemia in the Soviet Union has been confirmed; was not accidental but the result of the interaction of the three causes, namely that

- (a) Into this period fell one of the periodical waves of a great numerical increase of the water-rats, among which tularemia, acting as a population regulator, became particularly active and widespread;
- (b) Whereas in the past the water-rats were in general shunned or at least rather ignored by the people, now the authorities urged the large-scale hunting of these animals for the sake of their furs, offering attractive prices for each skin. As a result hunting of these rats became one of the main occupations of the population in the regions inhabited by the animals and thus far more people came under the risk of infection than had been the case in the past.<sup>1</sup>

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1. As aptly pointed out by Roubakine (1930), the situation thus became similar to that evolving earlier in the century in Transbaikalia, where intensified and indiscriminate hunting of the Siberian marmots, due to a greatly increased demand for the fur of these animals, led to an increased incidence of plague, culminating in the 1910-1911 Manchurian pneumonic plague epidemic.

## Tularemia-6

- (c) An efficient research laboratory had been established at Saratov under the direction of Nikanorov, the excellently qualified and keen workers of which were available for the investigation of plague-suspect outbreaks.

(see Nikanorov, 1928)

The first and historically most important outbreak recorded during the period under review was that observed in 1926 by Suvorov and his colleagues (1928) in the Astrakhan raion about 44-50 versts from the city of that name, which involved during the period from May to October (with an acme in June) about 200 persons. These patients suffered from an acute febrile disease leading to the formation of buboes which in 60% were situated in the groin region. There was no fatality and no evidence of a spread of the infection from man to man.

Considering the etiology of the outbreak, Suvorov and his associates stated that

"most likely will be the postulation of its connection with the water-rats (Arvicola amphibius L.) which just at the time of the appearance of the attacks penetrated in hitherto not observed numbers into the villages to save themselves from the major flood present in the year. Apparently it is also not accidental that the largest number of attacks was in male adolescents, the most active element in the fight against this enemy."

While bacteriological examinations made in the usual manner with the blood and bubo contents of the patients gave negative results, it was possible to produce a characteristic fatal affection in guinea-pigs infected subcutaneously or intraperitoneally with materials obtained by puncturing the buboes of patients and to maintain the infection through passage in susceptible animals (guinea-pigs, white mice, sisels and jerboas). Rabbits and grey rats (R. norvegicus) succumbed but rarely to experimental infection. Using Bailey's medium (glucose ascites or human serum agar with 0.2% cystin) it was possible to cultivate small, gram-negative immotile cocco-bacilli, which were agglutinated at titers of up to 1:800 by the serum of convalescents or that of test animals immunized through the administration of suspensions of infected organs inactivated by heating at 56°C.

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1. Rather illogically the name of this species has been changed to Arvicola terrestris.

Summarizing the results of these and additional observations, the authors stated that

1. The described attacks show a considerable similarity to bubonic plague both clinically and particularly in regard to the experimental findings in rodents.
2. Important differences are, however, the absence of plague bacilli and the present of another causative organism, negative serological reactions (for plague), the absence of contagiousness and of lethality.
3. The infection is most and, one may say, unusually virulent for rodents, one of which, the water-rat one may preliminary consider as the reservoir of the infection.
4. Though different in some respects, the infection is most similar to tularemia met with in North America.
5. The microbe isolated with the aid of passage through experimental animals may be considered as specific.

In 1926 also a tularemia-suspect outbreak in the Omsk Oblast of Western Siberia, south of Tobolsk, causally related to the hunting of water-rats, was recorded by Shukhov (1928). As mentioned by Zeiss (1932) in one of his articles dealing with the early incidence of tularemia in the Soviet Union, the disease was known among the local hunters under the name of khvor ('the ailment').

A similar outbreak was observed in the spring and early summer of 1927 in the Mirimov iurtes on the Irtysh (Tobolsk Okrug) by Ponomarev and Shain (75 attacks, 74 of which occurred in water-rat hunters). Recording this epidemic, Zarkhi (1929) stated that, independently from Suvorov and co-workers, Ponomarev and Shain had noted the similarity of the disease in question to tularemia.

Tularemia manifestations related to the hunting of water-rats were also observed in 1927 in the northern part of the Omsk Oblast on the shores of the Irtysh and Tavda rivers (Shukhov, 1928 and Shuster, 1930, quoted Olsuf'ev and Rudnev). Likewise, according to Gauzner and Belitser (1928), in the same year the presence of suggestive influenza-like affections was noted among water-rat hunters on the shores of the Oka River (an important affluent of the Volga) in the Spasski and Sasovskii uyezds of the Riazan government, a region in the European part of the Soviet Union where, as described below, a major tularemia outbreak took place in 1928.

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As shown by the following tabulation, the occurrence of affections identical with those described above was reported in 1928 not only from the European part of the Soviet Union and from areas in the basin of the Ob' River and its tributaries in West Siberia, but also in the Iakutsk area of eastern Siberia:

#### Tularemia or Tularemia-Suspect Outbreaks in the Soviet Union in 1928

<u>Area</u>	<u>Season</u>	<u>Recorded Incidence</u>	<u>References</u>	<u>Remarks</u>
<hr/>				
I. <u>Oka (Volga) Basin</u>				The outbreak was causally related to the spring floods and the unusually abundant water-rats. Infection of guinea-pigs with the bubo contents of patients produced a characteristic fatal infection which could be passed on to healthy animals.
Numerous villages of the Spasski and Kasimovskii uezds of the Riazan government and in the Melenkov Uezd of Vladimirsk government.	May	About 800 cases with 3 deaths, mostly among males 9-34 yrs. (particularly 12-20 yrs.) old.	Gauzner and Belitser (1928); Volferz (1928); Khaten-ever (1930).	
<hr/>				
II. <u>Ural River Basin</u>				The outbreak was causally related to the hunting of water-rats, in which the presence of the infection was proved.
a) Orenburg (now Chkalov) and Uralsk governments (8 villages).	May/ June	105(?106) cases.	Golov et al. (1928).	
b) Borodinskii and Ileksinskii raions.	Spring		Mazurovskii and Novitskii (1928) quoted by Nekipelov (1959).	These manifestations were also due to water-rat hunting.
<hr/>				

Tularemia-9

	<u>Area</u>	<u>Season</u>	<u>Recorded Incidence</u>	<u>References</u>	<u>Remarks</u>
III.	<u>Ob' Basin</u>				
a)	Samarov village, Tobolsk Okrug.	May	22 cases.	Zarkhi (1929, 1930)	Exclusively among water-rat hunters.
b)	IALuto- rovskii Raion on the shore of the Iset.	April/ June	?22 cases.	-"-	Among water-rat hunters. Diag- nosis retrospec- tively established through serologi- cal tests. Presence of tularemia in the water-rats and hamsters confirmed in 1929.
a)	Bolsharvovo on the Konda River.	June	10-12 cases.	-"-	Exclusively among water-rat hunters.
d)	Kushevat	June/ August	27 cases.	Zarkhi, l. c. and Shu- binski (1929)	In causal connec- tion with water- rat hunting.
e)	Muzhi vil- lage in the Tobolsk Raion on the Ob'.	-"-	56 typical cases.	Zarkhi, l. c.	Actually 7-8% of the population affected, mainly adolescents and adults up to 50 years. Though the outbreak coin- cided with the hunting season, contact with water-rats was not a sine qua non for infection.

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# Tularemia-10

<u>Area</u>	<u>Season</u>	<u>Recorded Incidence</u>	<u>References</u>	<u>Remarks</u>
IV. <u>Lena Basin</u>				Olsuf'ev and Rudnev considered this outbreak, which affected almost the whole male population, as vector-borne.*
IAkutsk ASSR near and in	June/ September	?	Dubrowinskii (1930)	

\* A suspicious outbreak occurring in 1924 in the north-eastern part of the IAkutsk ASSR was reported by Skalon (1949) and by Antsiferov and Pinigin (1957). As quoted by Maksimov, the first mentioned author "pointed to the strikingly localized character of the outbreak, connecting its development with the water-rats, with which the people had closest contact at the time of hay-harvesting and fishing." Apparently the water-rats were not hunted.

Particularly important observations, requiring further comment, were made in the course of these outbreaks by Golov and his associates and by Zarkhi. The conclusions arrived at by the first mentioned group of workers were that

"1. The clinical picture of the plague-like affections, observed in the spring of 1928 on the Ural River, corresponds to that in North America under the name of tularemia.

2. In the bubo contents (juice, pus), taken during the first two weeks of the disease, one can observe a virus pathogenic for guinea-pigs: the morbid changes of the succumbing animals are characteristic for tularemia; subsequently the virus can be easily maintained through passage in guinea-pigs, white and domestic mice.

3. In the water-rats - Arvicola amphibius L. - there exists an affection corresponding to the subacute form of tularemia described in wild rodents (ground-squirrels, wild rats); from the diseased and succumbed animals one can obtain a virus, analogous to that isolated from human sufferers.

4. From guinea-pigs, domestic and white mice, infected with either the human or the water-rat virus, one can easily obtain through cultivation on a coagulated egg-yolk

medium identical microorganisms, agglutinable with the serum of convalescents and producing, if introduced into the above mentioned laboratory animals, illness and death with changes analogous to those observed in (natural) infection with the above kinds of virus.

5. In the course of the work with the viruses four instances of laboratory infection of physicians resulted. This is in accord with the literature statements on tularemia.

6. Human infections are related to the skinning of infected water-rats - Arvicola amphibius L.

7. Apparently infection takes place mechanically during the skinning of the animals.

The role of the ectoparasites of the water-rats as vectors of the infection has not been clarified: the fleas of the genera Ceratophyllus and Ctenophthalmus observed on the animals, if tested under laboratory conditions, did not bite man."

Though these findings left little room for doubt that the affections observed in the water-rats and in man in the Soviet Union were of the same nature as the manifestations of tularemia as defined by American workers, final proof for the identify of the two diseases was obtained through Zarkhi (1929, 1930) who took care to send a specimen of his own serum - he had contracted the disease in the course of his investigations - as well as organs of infected guinea-pigs, preserved in glycerol, to McCoy in Washington. The latter found that Zarkhi's serum agglutinated an American culture of B. tularensis in a dilution of 1:640 and that the growths obtained from the organs of the test animals infected in the Soviet Union showed the typical features of the American strains of this organism. Identical findings were made by Zarkhi with a tularemia culture sent him by McCoy (see also Olsuf'ev and Rudnev).

As alluded to above, Zarkhi, quoting the histories of some tularemia patients who had not come in touch with water-rats or their skins, reached the important conclusion that

"a direct contact with the water-rat or its fur is not an indispensable condition for the infection. The causal connection of the above described outbreak (at Muzhi) with the hunting of water-rats manifests itself in the timely

## Tularemia-12

coincidence of these two phenomena. This coincidence, which repeats itself under the most different climatic and environmental conditions, has thus an important epidemiological significance and proves the essential role of a direct contact with (the) rats. But, I repeat, in a whole series of cases there must be a further link of the chain 'virus-rat-man'."

It would thus seem that Zarkhi was one of the first observers pointing to a possible role of blood-sucking insects in the conveyance of tularemia to man.

According to Olsuf'ev and Rudnev, tularemia attacks related to the hunting of water-rats were recorded in 1929 and 1930 in the Kargatskii Raion of the Novosibirsk Oblast, some of the patients showing evidence of a conjunctival infection. As these authors added, Mitskevich (1931) was the first observer in the Soviet Union confirming the tularemic nature of these eye affections.

As stated by Komarova (1945), quoted by Karpov and Tiazhkun (1961), single tularemia attacks among water-rat hunters had also been observed in 1929 in the Tomsk Oblast.

Turning attention to the important observations made in 1930, mention has to be made first of a tularemia outbreak taking place in the spring of that year in the Birkii Raion of the Bashkir ASSR on the Belaya River near its discharge into the Kama, a tributary of the Volga (Khatenever, 1934, quoted by Nekipelov, 1959, and by Olsuf'ev and Rudnev).

As recorded by Olsuf'ev and Rudnev, in the summer of 1930 a tularemia outbreak was detected in the Ushtabinskii Raion of the Taldy-Kurganskaia Oblast in the south-eastern part of the Kazakhstan by P. P. Popov and G. IA. Sinai,<sup>1</sup> which seemed exclusively of a vector-borne nature. Referring to this epidemic, Maksimov (1960) noted that (a) as recorded by Sinai (1935), it involved workmen camping in tents on the shore of the Karatal River; and (b) according to Shnitnikov (1932) a tularemia epizootic was present in that locality among tamarisk gerbils, small jerboas, M. musculus and Microtus arvalis. Olsuf'ev and Rudnev added that Sinai (1934) had proposed to call such vector-borne manifestations "spontaneous"

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1. No joint publication of these two authors could be found. Olsuf'ev and Rudnev quote in their reference list an article entitled "Tularemia in the rice sovkhoses of the Karatal River" by Sinai (1931).

(i. e. not related to the hunting of water-rats), but that Olsuf'ev (1939) introduced the more adequate name "transmissive" which had been generally accepted by the Soviet authors for the designation of vector-borne tularemia outbreaks.

Observations proving the role of blood-sucking diptera in the spread of tularemia were made also during an outbreak taking place in 1930 in the Barabinskii Raion of the Novosibirsk Oblast (see Kamanin and Leppianen, 1930; Rabin, 1931; Krol', 1933). As summarized by Maksimov (1960),

"V. I. Kamanin and O. N. Leppianen (1930) write that recently in July and August patients with signs of acute lymphadenitis were observed in the Kainsk Municipal Ambulatorium. Most often these affections were noted on the femur, more rarely in the axillary cavity and finally, on the neck, the submaxillary region and in front of the ear. One can claim, the authors state, that the penetration of the infection causing an acute inflammation of the lymph nodes, is the result of bites of insects, specially on the lower third of the leg...."

The case incidence amounted to almost 350, 97 of the attacks having been noted in Kainsk (now Kuibyshev). The vector-borne outbreak was preceded in April and May by a phase during which infections among water-rat hunters had been observed (Maksimov, 1960).

Sad to relate, Krol', who had confirmed the diagnosis of tularemia, succumbed to tularemic pneumonia due to a laboratory infection. Feeling his end approaching, he urged his colleagues to use his dead body for a study of the morbid anatomy of the disease. Thus, as Olsuf'ev and Rudnev justly state, Krol' deserves a place of honor in the history of tularemia research in the Soviet Union.

As summarized by Olsuf'ev and Rudnev, in the spring of 1930 manifestations of tularemia were observed among the workers of a meat-packing plant in Kurgan (Western Siberia) who had handled the frozen carcasses of hares. Attacks due to the same cause were also noted among the workers of this plant in the spring of 1931 and early in 1932 (Berezin, 1931, 1934) and infections were also noted among the personnel of eating establishments to which the salted meat of the animals had been furnished.

Evaluating the achievements made during 1926-1930, Olsuf'ev and Rudnev pointed out that in this period not only the frequency of tularemia manifestations in the Soviet Union had been confirmed and much information on the etiology,

#### Tularemia-14

epidemiology and the clinical aspects of the disease had been obtained, but satisfactory progress had been made also in the laboratory diagnosis of the infection. The technique of culturing its causative organism had been mastered and the specificity and diagnostic value of the agglutination reaction had been established. Since, however, owing to the late appearance of the agglutinins in the serum of the patients this method was unsuitable for an early diagnosis of the disease, the application of an allergic reaction for this purpose was of great value. The use of this method was first suggested by Bychkov and Rappoport in 1931 (see also the German article by Rappoport and Bychkov, 1931) who (a) found that the intracutaneous injection of "tularin" (i.e. an antigen obtained by heating saline suspensions of tularemia bacilli grown on cystin-agar for 1/2 hour at 60°C) produced within 24-48 hours an allergic reaction in tularemia-infected guinea-pigs; and (b) noted the presence of an analogous reaction in a tularemia patient tested on the 8th day of illness. However, as summarized by Olsuf'ev and Rudnev, it was only during the second period of tularemia research (1931-1941) that the diagnostic value of the tularin reaction both for the early bedside diagnosis and the retrospective diagnosis of the infection was fully established by Fedorov and Gol'dshtern (1934), Volferz (1934) and subsequent workers.

#### 3. Period from 1931 - 1940

The almost bewilderingly ample information on tularemia manifestations during the period from 1931-1940, culled from the summary of Nekipelov (1959) and numerous other sources, may be recorded as follows:

<u>Year</u>	<u>Locality</u>	<u>Season</u> (Months)	<u>Remarks and References</u>
1931	Barabinski Okrug, Novosibirsk Oblast	I-V	Kamanin (1935), quoted by Nekipelov
	Saratov Krai (Balashov town on Khopra River)	VII-IX	Mosquito-borne outbreak described by Fedorov and Sivolobov (1935). Gaiski contracted tularemia there in the laboratory (Olsuf'ev and Rudnev)
	Tularemia epizootic among susliks ( <u>Citellus</u> ) in the Kazakh SSR		Voskresenskii ( <u>Rukovod- stvo po tuliariemii</u> , 1942) quoted by Nekipelov

Tularemia-15

<u>Year</u>	<u>Locality</u>	<u>Season (Months)</u>	<u>Remarks and References</u>
1932	Azovo-Chernomorskii Krai (later Rostov Oblast)	Spring	Water-rat caused outbreak described by Khatenever (Thesis, 1935, quoted by Nekipelov). According to Stradomskii (1935), the outbreak involved also the environs of Rostov/Don
	Kazakh SSR, Alma- Atinsk Oblast		Water-rat epizootic (Fedorov, 1942, quoted by Nekipelov)
1933	Azovo-Chernomorski Krai (shore of the Mertvyi Donets)	VII-VIII	Vector-borne outbreak, re- corded according to Nekipelov by Somov and Romanova in the <u>Izvestia gosud. mikrobiol. instituta</u> in Rostov, 1937
	Azovo-Chernomorski Krai	IX-II	This outbreak, which lasted until the end of February, 1934, is described below
	Kotelnikovskii Raion, Stalingrad Oblast	X-XII	See text below
	Ukrainskaia Oblast (former Khar'khov Oblast)		Shmuter (1941) quoted by Nekipelov
	Kazakh SSR (Alma- Atinsk Oblast)		Water-rat epizootic recorded, according to Nekipelov, by Fedorov (1942)
-"-		Winter	Wide-spread mouse epizootic in the winter of 1933/1944 recorded by Berdnikov et al. (1935)

#### Tularemia-16

Important observations made in the course of the above mentioned outbreaks in the Rostov and Stalingrad oblasts may be set forth as follows:

The investigations made by Miller (1935, 1937) and his co-workers during the big and wide-spread tularemia outbreak in the Azovo-Chernomorski Krai in the winter of 1933-34 were of great importance because they established the etiological role of domestic mice in tularemia. Summarizing the findings he and his associates had made in this respect, Miller (1935) stated that (a) grey mice (M. musculus) can be the source of massive tularemia epidemics following their mass multiplication and the appearance of an epizootic; (b) the infection of the mice is derived from the water-rats and insects may convey it; and (c) human infection may be produced by food products or by water contaminated by the mice. It is noteworthy in the latter connection that, as stated by Miller, Somov (1934, 1937, 1939) twice succeeded in cultivating tularemia bacilli from the water of a well.

As summarized by Khatenever (1947), the above described tularemia epidemic, the true nature of which was recognized only with considerable delay, was characterized by the prevalence of generalized infections, present in 80-95% of the attacks. The buboes present in a small number of the patients were localized in the submaxillary and cervical regions.

The outbreak in the Kotelnikovo Raion of the Stalingrad Krai, described by Berdnikov (1934), also related causally to a widespread and most massive epizootic among M. musculus and probably also in Microtus arvalis. It is of great interest to note that the great increase of these rodents preceding the tularemia epizootic in the area was not an isolated phenomenon but, as described by Feniuk (1934), a phase in a massive multiplication of the mice and allied species in the whole south-east of the European part of the USSR which, first observed in Georgia and Daghestan in 1931, had eventually reached the Stalingrad Krai.

Berdnikov stated to have seen himself about 40 patients with buboes in various parts of their bodies, but drew attention to the frequent occurrence of grippe-like affections in the area, at least some of which no doubt also the result of an infection with B. tularense. He arrived at the conclusion that the primary source of the outbreak was a permanent entrenchment of the infection among the water-rats.

## Tularemia-17

According to the summary of Nekipelov, in 1934 tularemia manifestations were observed in the following areas:

<u>Locality</u>	<u>Season</u>	<u>Nature of Outbreak</u>	<u>Remarks</u>
Volga Delta	Summer	Vector-brone	See Novikova (1946) and Kondrashkin (1955).
Voronezh Oblast (2 raions)*	Spring and September	Related to water-rat hunting.	The town of Voronezh became apparently involved.
Omsk Oblast	Autumn	Vector-borne	Described by Skoromokhov in the newspaper " <u>Sovetskii sever</u> ," 8/XII, 1934.
Rostov Oblast	January-February	Related to agricultural operations.	Recorded by Somov (1937 b).
Ukraine	April-May	Related to the hunting of water-rats, hamsters and hares.	Ruchkovskii et al., quoted by Olsuf'ev and Rudnev.

\* According to Sil'chenko (1962) two tularemia attacks had been observed already in the Povorinskii Raion of the Voronezh Oblast in 1930. As stated by this author, the case incidence in this oblast in 1934 was 103.

A further small but interesting outbreak in the Ust'-Kur-dium village of the Saratov Krai was described by Berdnikov and his associates (1935) who proved in the spring of 1934 the presence of tularemia in one patient (infected through the bite of a sisel) by bacteriological methods and obtained evidence for past infection in 13 other persons through skin tests with tularin. Considering that (a) they were able to confirm the presence of tularemia in a water-rat; (b) a tularemia epizootic had been present in the area among M. musculus and steppe lemmings (Lagurus lagurus) during the winter of 1933/34; and (c) as proved the above mentioned observation, the infection was also present in the sisels (susliks), without, however, attaining epizootic proportions, the authors came to the conclusion that

"the mouse-like rodents served as a link in the transition of the tularemia virus from the fundamental reservoir, the water-rat, to man, while the suslik was a side-link of the epidemiological chain."



### Tularemia-18

Noteworthy tularemia epizootics were also recorded in 1934 in the Stalingrad Oblast by Kazantseva and Gorokhov (1934) in susliks, house-mice and steppe lemmings, and in the Kazakh SSR by Tumanskii and Kolesnikova (1935) in susliks (Citellus pygmaeus).

Kazantseva and Gorokhov described the presence of an intensive epizootic among susliks (Citellus pygmaeus) and also among lemmings (Lagurus lagurus) starting in April 1934 in the Kotelnikov and Stalingrad raions of the Stalingrad Oblast. In their opinion the infection of the susliks was of a secondary character, being due to the close contact of these animals with M. musculus, Microtus arvalis and L. lagurus. The same opinion was also expressed by Volferz and her co-workers (1934) who made in the course of this outbreak important observations on the possible role of the rodent ectoparasites in the spread and maintenance of tularemia. Infecting susliks and guinea-pigs with suspensions of gamasidae and of fleas collected from burrows, the rodent-hosts of which had succumbed, these workers obtained evidence suggesting that the gamasidae as well as the flea Ctenophthalmus pollex and possibly also Ct. orientalis were capable of carrying over the infection during the hibernation period and of causing in spring an epizootic among the susliks. It is important to note in this connection that both the above mentioned flea species were found to be frequent on the water-rats as well as on M. arvalis and L. lagurus.

The observations of Tumanskii and Kolesnikova proved the occurrence of a widespread tularemia epizootic among susliks in the Dzhambaitinskii Raion of the West-Kazakhstan Oblast in the spring of 1934. It is interesting that, while four of the workers who dissected and examined the animals, contracted tularemia, the four men of the auxiliary staff, who caught the susliks and brought them to the laboratory, remained healthy. Similarly the disease appeared to be rare among the inhabitants of the raion, even though they engaged in large-scale hunting of the animals.

Recording the incidence of tularemia in 1935, Nekipelov (1959) referred to the following manifestations:

<u>Locality</u>	<u>Season</u>	<u>Remarks</u>
Lipetskii Raion of the Voronezh Oblast	April	Related to the hunting of of water-rats.
Moscow Oblast (Kashira Station)	Spring	According to Tsareva (1959) this outbreak, taking place in an agricultural school, was the result of a water-borne infection.

### Tularemia-19

<u>Locality</u>	<u>Season</u>	<u>Remarks</u>
Kazakh SSR (Alma-Ata Oblast and 2 other raions).	Summer	Epizootics among (2) water-rats; (b) susliks; (c) lemmings.

Rather suprisingly Nekipelov thus made no mention of the tularemia outbreak in the Taiginskii Raion of Western Siberia (now called the IAshinskii Raion of the Kemerovo Oblast), which is of historical importance because in its course Karpov and Antonov (1936 a, b) confirmed the preliminary observations of Miller and his associates on the occurrence of water-borne tularemia epidemics. The outbreak described by Karpov and Antonov took place among gangs of workers staying in the fields to harvest hay, almost all members of these groups contracting the disease. Most of the patients suffered either from the anginose form of tularemia or showed features of a generalized infection, but conjunctival affections, leading to an involvement of the regionary lymph nodes, were also noted. Laboratory investigations not only confirmed the clinical diagnosis of tularemia, but proved the abundance of virulent tularemia bacilli in the water of a brook used by the affected workers for the purposes of drinking and washing.

According to Nekipelov (1959), tularemia manifestations were recorded in 1936 in (a) the Voronezh Oblast (presumably water-borne outbreak in May-July); (b) the Narymskii Krai of the Tomsk Oblast (water-borne outbreak mentioned also by Selezneva, 1948) and (c) in the Surgutskii Raion of the Omsk Oblast (vector-borne outbreak taking place during the hay-harvest). As added by Maksimov (1960), the last mentioned epidemic in the lower Ob' region affected also two raions of the Tiumen Oblast. Moreover, as stated by Kositsina (1958), a large tularemia epidemic, connected with an increase of the water-rat population, took place on the middle course of the Ob' in the Tomsk Oblast.

Epizootics among water-rats and susliks continued to be reported from the Kazakh SSR (Nekipelov).

Though, as will be discussed below, the incidence of tularemia in 1937 was apparently heaviest in Siberia, the disease seems to have been active as well in some areas of the European part of the Soviet Union. Thus Olsuf'ev and Rudnev referred to a vector-borne outbreak taking place in the summer of that year in the Don Delta, which was particularly noteworthy because during its course Somov and his associates (1940)

## Tularemia-20

succeeded to cultivate for the first time the causative organisms from horse-flies. To judge from a remark by Borodin and his associates (1959), tularemia was also manifest in 1937 in the Stalingrad Oblast.

In Siberia the presence of tularemia was reported during the year under review not only in the west (see below) but also in the Irkutsk Oblast where, as recorded by Klets (1957), a vector-borne outbreak took place in the Nizhne-Udinsk Raion. As Maksimov (1960) noted, besides this also the Nizhne-Ilimsk and Bratski raions were retrospectively found to have been involved (Altareva et al., 1957).

The outbreaks recorded in 1937 in Western Siberia involved (a) the Novosibirsk Oblast where, coincident with a greatly increased frequency of the water-rats 9 raions became affected (Nekipelov, 1959; Maksimov, 1960) and (b) the Tomsk Oblast. As described by Komarova (1945), the epidemics rampant in the latter area in 1937 and also in the following two years started simultaneously with the hunting of water-rats at the end of April or in early May, reached their acme at the end of the latter month and sharply declined when the hunting season ended at the end of June. 84% of the patients admitted to have been in contact with water-rats. However, as had been noted already by some of the early observers, contact with the fresh carcasses of these animals was far more dangerous (75 infections among 200 persons so exposed) than that with 3-4 days' old carcasses (5 infections only in 120 persons having such contact).

Besides the water-rats chipmunks were involved in the epizootics. The handling of their skins was occasionally responsible for human infections. An interesting instance was also noted in which horse-flies, brought into a village with a drove of cattle, appeared to be responsible for the infection of 35 persons who had been bitten by these insect.

As summarized by Maksimov, a mass multiplication of the water-rats in the Omsk, Tiumen and Kurgan oblasts in 1937 also led to tularemia epizootics and human attacks of the disease.

According to Nekipelov's tables, in 1938 tularemia outbreaks were recorded in (a) the European part of the Soviet Union in the Moscow, Orlov, Riazan, Saratov, Tula and Voronezh oblasts; and (b) in the Novosibirskii Oblast and the Altai Krai of Siberia. As mentioned above, tularemia became again epidemic in the Tomsk Oblast. Moreover, as described by Lebedev (1949; see also Lebedev, 1953, 1957), the Kemerovo Oblast suffered severely from tularemia during the period from 1938-1940. The outbreaks there were according to this author mostly water-borne, while insect-borne manifestations were absent.

## Tularemia-21

Referring to the above mentioned manifestations in the European part of the Soviet Union, Olsuf'ev and Rudnev stated that the major outbreaks in the Moscow, Orlov, Riazan and Tula oblasts were causally related to agricultural operations. Detachments were sent out to fight these epidemics and the base laboratories established by them were utilized for the creation of permanent tularemia stations in the Moscow, Riazan, Tula and Voronezh oblasts.

As stated by Olsuf'ev and Rudnev, the members of the expedition sent to the Mikhnevskii Raion of the Moscow Oblast

"first established the role of the common voles (Microtus arvalis) as a source for the mass infection of man (natural tularemia infection in these animals had first been detected in 1936 by D. A. Golov in the vicinity of Alma-Ata) and found a number of other carriers of the infection among the rodents and insectivora. For the first time in the USSR the possibility of a tularemia infection of the cattle, pigs and horses was established (N. N. Uzonov) and the presence of tularemia in sheep was confirmed. Tularemia in these animals had been observed first by Dorofeev and Gorokhov (1938) in the Stalingrad Oblast. The work of the Mikhnevskii expedition was continued in 1939-1941 under our direction, when the role ixodes ticks in the prolonged harborage of the infection during the interepidemic periods was established."

Dealing with the year 1939, Nekipelov referred to a reappearance of tularemia manifestations in the Tula and Voronezh oblasts as well as to extensive outbreaks in the Novosibirsk and Omsk oblasts and in the Altai Krai. A recrudescence of the disease was reported by Komarova in the Tomsk Oblast while, according to Lebedev, the tularemia situation in the Kemerovo Oblast became more serious. The occurrence of a water-borne epidemic in the Saratov Oblast was mentioned by Selezneva (1948).

During the meeting of the First Congress on Parasitological Problems held in 1939, Olsuf'ev (1939) surveyed the knowledge available in regard to the reservoirs and vectors

## Tularemia-22

of tularemia in the light of the just propounded teachings of Pavlovskii on the infectious processes occurring in natural foci ("natural focality").<sup>1</sup>

According to Nekipelov, tularemia manifestations were recorded in 1940 in the following areas: (a) Stalingrad Oblast (vector-borne outbreak in summer); (b) Ordzhonikidzevskii (Stavropol) Krai (outbreak related to agricultural operations due to epizootics mainly among M. musculus - see Ter-Varatanov 1943 and Maiskii, 1944); (c) Omsk Oblast (vector-borne outbreak in the Samarskii Raion in autumn); (d) Novosibirskii Oblast, where 16 raions became involved; (e) Altai Krai (outbreaks in the Barnaul and five other raions); and (f) Buriat-Mongol Republic, where in autumn an outbreak connected with the hunting of musk-rats (Ondatra zibethica) took place. As reported by Lebedev, the Kemerovo Oblast suffered to a lesser degree than in the preceding year.

The just mentioned outbreak in the Kabanskii Aimak of the Buriat-Mongolian Republic in November/December 1940, which was followed by some sporadic cases in January 1941, was described by Linnik (1957), according to whom the occurrence of the disease in 24 hunters or trappers of musk-rats was confirmed with the aid of tularin tests. In the course of investigations made in 1941 tularemia cultures could be isolated from musk-rats in 9 instances, from Ungur voles (Microtus maximoviczi Schrenk) twice, from house-mice and from a sheep once respectively and also from a pool of gamasides (Macrolaelaps multispinosus).

Though the intense epizootic in 1940-1941 was confined to the musk-rats and these animals were the means of conveying the infection to man, Linnik postulated that the manifestation of tularemia in the Kabanskii Aimak in 1940 was not causally related to the importation of this species of rodents in 1934 (see Antsiferov et al., 1957 a) but that the disease had been pre-existent in the region. In fact no evidence of tularemia could be detected in the locality from where the musk-rats had been imported.

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1. As stated by Maksimov (1960), Golov "showed in 1933 already the role of a number of ticks in the maintenance of the enzootic foci and established together with V. N. Fedorov (Golov and Fedorov, 1934) that the tularemia bacillus, if coming into the organism of the larva, is afterwards preserved through all stages of the development of the tick." Nymphs of thus infected larvae were capable of conveying the infection to small rodents.

As Linnik added, a few further persons showing positive tularemia reactions were detected in 1943 and 1944 and moreover in the latter year two patients recovering from bubonic attacks of the disease were found.

A detailed description of the ectoparasite fauna in the Kabanskii Aimak was given by Fedorova in 1957.

It should be noted with great attention that Jusatz (1952), relying upon data supplied by German observers, reported also the occurrence of a tularemia outbreak lasting from November 1940 to March 1941 and involving 30,000 persons

"in the lowlands of the Kuban River, in the Voroshilovsk and eastern Krasnodar areas with eastern and south-eastern spread after previous sporadic cases 1938 in Aleksandrowsk and a winter epidemic 1939/1940."

According to him besides field mice a considerable number of other species including even domestic animals were involved in the epizootic responsible for the 1940-1941 outbreak.

Assessing the progress in tularemia research made during the period presently under review, Olsuf'ev and Rudnev drew particular attention to the fundamental studies on the pathology and immunology of the disease by Gaiskii and El'bert, recorded in a series of articles appearing in 1941.<sup>1</sup> These studies laid the foundation for the immuno-prophylaxis of the disease. Gaiskii and El'bert had at that time already a weakly virulent tularemia strain which proved immunogenic in experimental animals as well as in man. However, for reasons beyond their control they had to interrupt their work and could resume it only after some years.

#### 4. Period from 1941 - 1949

Referring to the ominous increase in the incidence of tularemia during the period from 1941 to 1949, i.e. the

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1. For the convenience of record the history of tularemia in 1941, when the operations of World War II started in the Soviet Union, will be dealt with in the following section of this review.

#### Tularemia-24

time of World War II and the years immediately following this conflict, Olsuf'ev and Rudnev stated that

"The increase of recorded attacks was related not only to the improved diagnosis of tularemia,<sup>1</sup> but also to an intensification of the epizootics among the rodents due to their mass multiplication. During the war in particular massive tularemia epizootics were observed in the territories temporarily occupied by the German invaders, e. g. in the Ukraine, the Stalingrad and Rostov oblasts, etc. and also in the oblasts of the forest-steppe zone of the European part of the USSR, where the agricultural work was interrupted by the war operations (Tula, Voronezh, Riazan, Orlov and Kursk oblasts and others). Tularemia was (also) observed in the contending armies, the German doctors, not acquainted with the disease, first diagnosing it as Volhynian fever (Volkov, 1944 and others).<sup>2</sup> Reports on a high incidence of tularemia made by Jusatz (1952), Trautmann (1953) and others."

The tularemia situation in the western parts of the Soviet Union during the war years was briefly but well characterized by Apekhtin (1945) thus:

"The epidemiological importance of tularemia infection by inhalation became particularly great in the oblasts and raions temporarily occupied by the fascist invaders. In these oblasts extraordinarily favorable conditions were created during that time for a mass multiplication of the mouse species of rodents. Thus of great

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1. It is important to note in this respect that the registration of tularemia cases was made obligatory in the Soviet Union in 1941 (see Olsuf'ev, 1959).
  2. It is of great interest to note in this connection that, as maintained by several Soviet authors (see e.g. Gromashevskii, 1947, Volkov, 1948 and Maksimov, 1948) and also admitted by Olsuf'ev and Rudnev, the manifestations of Volhynian or trench fever rampant during World War I had been partly of a tularemic nature.

importance was the suspension of all agricultural and anti-rat operations, the presence of large areas of uncultivated arable land, the delayed harvesting, the massive abandonment of unthreshed grain stacks on the fields, the mass destruction of grain storehouses and elevators, the abundant overgrowing of the farm plots and whole settlements (destroyed by the fascists)...."

Though a quite voluminous literature deals with the problems of tularemia arising during World War II,<sup>1</sup> exact data on the incidence of the disease during that period both in the civilian population of the various parts of the Soviet Union and in the contending armies are rather scanty. Schmidt (1947) stated in this connection that

"Though on account of the events of the war no exact statistical data are available for the last years, the figures which became known during the war clearly show the great danger represented by this disease for the European continent. During 1926-1928 the tularemia epidemics among the population on the shores of the large Russian rivers due to the capture of water-rats, the local tularemia reservoir, involved some hundreds of cases. The new data of the years 1940-1942 speak already of tens of thousands up to 100,000 cases during an epidemic in the population of some parts of the country. Thus the tularemia graph for the Rostov area alone shows an increase from 8,500 cases in November 1941 to 14,000 cases in January 1942...."

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1. Noteworthy Soviet publications referring to this subject are those of Rudnev (1942, 1943); Kalabukhov (1943 a, b); Rafalovich (1943), Volkov (1944, 1948); Nesgorov and Chasovnik (1944); Maiskii (1944, 1945); Apekhtin (1945); Malyi (1945); Boev (1946); Ugriumov (1946); Khatenever (1948); Maksimov (1948); Olsuf'ev (1959); Tsareva (1959). Important articles were also published by Akinfiev, Rudnev and Kalabukhov in the standard work "Experience of the Soviet medicine in the great patriotic war" which was not available to the present reviewer. Specially noteworthy articles by German observers were those of Schmidt (1947); Schulten (1945); Juszatz (1952) and Trautmann (1953). Ample reference lists, enumerating the articles in point by other German authors, are appended to the publications of Schulten and Juszatz.



#### Tularemia-26

According to Jusatz (1952) the total incidence in that area from November 1941 to June 1942 amounted to 37,000 cases. Further, while unable to state the case incidence in most of the contemporaneous tularemia outbreaks tabulated by him, the author also referred to an epidemic taking place from November 1940 to March 1941 in the North Caucasus area which involved 30,000 persons.

According to data recently published by Sil'chenko (1962), the tularemia incidence in the Povoriinskii Raion of the Voronezh Oblast, which had been moderately high in 1934 (103 cases) and again in 1938 (185 cases), reached markedly higher levels in 1943 (377 cases), in 1945 (1,481 cases) and in 1946 (347 cases). As Sil'chenko added, the disease was rampant in the Voronezh Oblast as a whole in 1943 and 1945 (and again in 1948 and 1949).

In an article published in 1946, Isakov and Sazanova referred to a total of 109 tularemia outbreaks identified by them in Western Siberia and also spoke of 9,585 patients with a known history of the disease in the Novosibirsk and Omsk oblasts. Since these figures refer evidently also to the period before the war, it would seem that during the latter the manifestations of the disease in Western Siberia were not as rampant as those in the European part of the Soviet Union, especially in its west.

Summarizing the information available in regard to the tularemia incidence in the armed forces, Schmidt maintained that in the winter of 1941 the Soviet Army suffered so severely from this disease that in a part of the units over 50% of the combat troops were unfit for action. For this reason a large organization for the prophylaxis of tularemia was created under the auspices of the Red Army. Its main attention was directed to anti-rodent campaigns and the sanitation of the wells whose water, because contaminated by rodent carcasses or the excretions of diseased animals, often served as vehicle of the infection. Schmidt speaks in this connection of a fight against the rats, but it can be gathered from papers like those of Rudnev (1942) and Kalabukhov (1943), that main attention was paid in the anti-rodent campaigns to the mouse species which were responsible for the causation of the disease in the war-affected areas.

### Tularemia-27

As stated by Rudnev (1943), the incidence of the various forms of tularemia in the Soviet armed forces was

Bubonic type	4.8%
Generalized form	14.9%
Respiratory type	80.3%*

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\* 12.4% with evidence of pneumonia and 67.9% with grippe-like affections.

42.9% of the patients were but slightly affected, 53.5% had moderately severe and 3.6% severe attacks of the disease. The mortality was invariably less than one percent.

Schmidt admitted that tularemia attacks were also frequent in the German armies fighting on the eastern front but maintained that neither their number nor their character gave any cause for alarm. The affected soldiers ascribed their infection mainly to contact with sick or dead mice or to the consumption of food products contaminated by these animals. Unboiled well water, even though its consumption was prohibited, also served sometimes as source of the infection. According to Bogendörfer (quoted by Schulten), the type incidence of tularemia in the German armed forces was:

Ulceroglandular form	0.2%
Glandular	30.0%
Typhose (generalized) form	70.0%

Data on the incidence of tularemia during the period presently under review year by year may thus be summarized:

1941: As recorded by Nekipelov (1959), tularemia outbreaks in 1941 were recorded in the following areas of the Central European part of the Soviet Union:

### Tularemia-28

<u>Oblast</u>	<u>Season</u>	<u>Remarks</u>
Orlov Oblast	January to May	Directly related to agricultural work.
Penza Oblast (Serdobskii Raion)	Autumn	Same etiology.
Riazan Oblast (3 raions)	Spring	-
Voronezh Oblast (a) 3 raions	February to June	Causally related to the hunting of water-rats.
(b) Lipetskii Raion	December 1941- February 1942	Related to agri- cultural work.

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Jusatz (1952), quoting German observers, referred also to an outbreak in villages between Orel and Briansk and south of Orel, taking place in the winter of 1941/1942.

Ample studies on the ecology of tularemia were made during the period from 1938 to 1941 (and again in 1946) in the Mikhnevskii Raion of the Moscow Oblast by Olsuf'ev (1947), according to whom three types of foci of this infection could be distinguished in the central zone of the European part of the Soviet Union - a field-meadow type, a valley-floodland type and a forest type. Data on the occurrence of an epizootic among the field mice in the Mikhnevskii Raion during the winter of 1941/1942 were summarized by Maksimov (1960).

Tularemia outbreaks involving 5 raions of the Kharkov Oblast (Ukraine) in January 1941 were recorded by Nekipelov. Jusatz (1952), also referring to this region, reported on the authority of German observers that the epidemic in the Kharkov area which lasted from December 1941 to March 1942 involved besides the whole civilian populations also 4,500 cavalry soldiers (?). He likewise noted that at the same time 40 German soldiers were attacked by tularemia in the Gomel Oblast (Belorussia).

The occurrence of tularemia during the year under review in the Volga Basin was according to Nekipelov as follows:

Tularemia-29

<u>Oblast</u>	<u>Season</u>	<u>Remarks</u>
<u>Stalingrad Oblast:</u>		
(a) Astrakhan	August	Vector-borne outbreak.
(b) 4 raions including the Sredne- (middle) - Akhtubinskii Raion.	July-September	According to Borodin (1958) 79 tularemia cases were recorded in the northern part of the Volga-Akhtuba floodland in 1941.
(c) 12 raions	November 1941 - March 1942	Also referring to this outbreak, related to agricultural operations, Maiskii (1944) pointed to the danger created by the presence of many unharvested fields. (See also the summary on the tularemia manifestations in the Stalingrad Oblast by Borodin et al., 1959, and the articles dealing with the incidence of the disease in the Volga Delta by Novikova [1951] and Kondrashkin [1955].)
<u>Saratov Oblast:</u>		
(a) 8 raions	? July-September	Related to agricultural operations.
(b) 12 raions	November 1941-June 1942.	Same etiology.

According to Nekipelov's tabulations, tularemia outbreaks in the Rostov Oblast were recorded (a) in the spring of 1941 in the Rozdorskii Raion (due to the hunting of water-rats) and (b) in 44 raions of the oblast during the period from December 1941 to March 1942. As noted above, reference to this most severe epidemic was made also by Schmidt (1947) and Jusatz (1952).

### Tularemia-30

Tularemia outbreaks in the Caucasus and Transcaucasus areas were reported by Nekipelov thus:

<u>Area</u>	<u>Season</u>	<u>Remarks</u>
Baku town, Azerbaidzhansk SSR.	February-March	Apparently related to the importation of grain.
Kabardino-Balkarskaia ASSR.	?	No details.
Krasnodar Krai (Kannibalovskii and Pokrovskii raions).	November 1941-February 1942.	To judge from the report of Jusatz, this outbreak was related to an epizootic among the field mice. No details are known about a tularemia outbreak in the Krasnodar Krai taking place according to Nekipelov earlier in 1941.
Ordzhonikidzevskii Krai (3 localities).	Summer	No details.

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Referring to the incidence of tularemia in Siberia, Nekipelov mentioned 1941 outbreaks only in 10 raions of the Novosibirsk Oblast including the Asinovskii Raion, the Samarskii Raion of the Omsk Oblast and in 7 raions of the Altai Krai. It deserves attention, however, that (a) Glass (1948 a, b) gave in two interesting articles a description of a vector-borne tularemia outbreak taking place in 1941 in the settlements of deportation Asino and IAia (Tomsk Oblast); (b) Karpov and Tiazhkun in a recent article also referred to a recrudescence of the disease in the Tomsk Oblast in that year; and (c) as quoted by Maksimov, a 1941 tularemia outbreak was observed by Formozov (1947) in the IAmlo-Nenetskii National Okrug of the Tiumen Oblast.

In regard to the Kazakhstan, both Nekipelov and Kalacheva and her associates (1937) recorded the occurrence of tularemia during the year under review in the valley of the lower Chu River in the Dzhambul'skaia Oblast. It is interesting that according to the last mentioned observers the human outbreak in that area was causally related to an intense epizootic among hares (Leupus tolai).

Tularemia-31

1942: Data on the occurrence of tularemia in the European part of the Soviet Union, except the Ukraine and the Volga Basin (see below), during the year of 1942 have thus been recorded by Nekipelov:

<u>Oblast</u>	<u>Season</u>	<u>Remarks</u>
Ivanovskaia Oblast (Sobinskii Raion)	July- August	Vector-borne outbreak.
<u>Kalinin Oblast:</u>		
(a) Ostashkovskii Raion.	January	Water-borne outbreak.
(b) 12 raions	June- September	Vector-borne outbreak.
Kirov Oblast	July- September	Vector-borne outbreaks in 6 raions. According to Ogarkov et al. (1960), this was the first known tularemia manifestation in the Oblast.
Kursk Oblast	?	No details known.
Leningrad Oblast	July- October	Vector-borne outbreaks in 4 raions. The epidemic in the Lychkovskii Raion, involving besides the civilian population the personnel of an army (total cases 182) has been described by Beletskii (1948). Besides various mouse species water-rats were found infected.
<u>Moscow Oblast:</u>		
(a) 14 raions in- cluding the Mishnevskii Raion (see also Maksimov, 1960).	January- May	The outbreaks were, accord- ing to Nekipelov, causally related to agricultural operations, but a water- borne epidemic was also described by Tsareva (1959).
(b) 6 raions	July-August	Water-borne outbreaks.

Tularemia-32

<u>Oblast</u>	<u>Season</u>	<u>Remarks</u>
Orlov Oblast	Winter	Tularemia manifestations causally related to agricultural operations in 4 raions. This outbreak was apparently also recorded by Jusatz (1952).
<u>Penza Oblast:</u>		
(a) Danilovka Village	Spring	Water-borne outbreak.
(b) Gorodishenskii Raion	July-September	Vector-borne outbreak.
(c) 3 raions	Autumn	Outbreaks connected with agricultural operations.
<u>Riazan Oblast:</u>		
(a) 22 raions	January-April	Same etiology.
(b) 3 raions	August-September	Vector-borne outbreaks
Tambov Oblast (Muchkanskii Raion)	December	Related to agricultural operations. (To judge from a map in the book of Maksimov, outbreaks continued to occur in this oblast from 1942 to 1945.)
Tula Oblast	January-May	Causally related to agricultural operations.
Voronezh Oblast (Borisoglebskii Raion)	April-May	Outbreak partly water-borne, partly related to agricultural operations.

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As stated by Nefedov (1960), tularemia also became manifest in 1942 (for the first time) in the Vladimir Oblast, where during the period from June to August an outbreak involving about 100 persons took place.

Tularemia-33

According to Nekipelov a tularemia outbreak due to a murine epizootic was recorded in January and February 1942 in 6 raions of the Ukraine.

1942 outbreaks in the Volga Basin were reported by Nekipelov as follows:

<u>Oblast</u>	<u>Season</u>	<u>Remarks</u>
Kuibyshev Oblast	June-September	Vector-borne outbreak.

Stalingrad Oblast:

(a) 7 raions	Spring	-
(b) Astrakhan	July-August	Vector-borne outbreak.
(c) 24 raions	September-December	Causally related to murine epizootics. According to Borodin (1958), 142 tularemia cases were reported at that time in the Volga-Akhtuba floodlands.

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The occurrence of tularemia in three raions of the Ordzhonikidzevskii Krai during the year of 1942 was mentioned without details by Nekipelov.

Tularemia outbreaks in Siberia occurred according to this author during 1942 in (a) the Novosibirsk Oblast (4 raions); the Omsk Oblast (one vector-borne, one water-borne outbreak and a third related to agricultural work, all during the period from July to October) and (c) the Altai Krai (vector-borne outbreaks in 5 localities). As added by Maksimov, an excessive increase in the number of the water-rats in the Tobolsk, Uvatskii and Samarovsk raions on the Irtysh River and in the Kondinskii Raion on the Konda River led to the appearance of tularemia epizootics among these animals, which in their turn were responsible for manifestations of the disease in the population of several settlements. Further, according to Karpov and Tiazhkun (1961), tularemia became recrudescant during 1942 in the Tomsk Oblast.



#### Tularemia-34

Nekipelov's report also indicates that during 1942 tularemia manifestations were observed in the Kazakhstan in (a) the Ust'-Kamenogorskii and Kugalinskii raions (water-borne epidemics in summer) and (b) the Gur'evskaia Oblast (vector-borne outbreak in one raion during the period from July to August). To judge from an article by Kucherov et al. (1958), the incidence of tularemia in the West-Kazakhstan Oblast during 1942-1943 was considerable.

1943: Though presumably manifestations of tularemia continued to exist or became recrudescant in 1943 in most of the previously affected localities in the European part of the Soviet Union, definite information in point is available only in regard to the following areas:<sup>1</sup>

According to Tsareva (1959) it had been noted that while outbreaks related to agricultural activities had become markedly less frequent in the Moscow Oblast by 1943, water-borne epidemics continued to occur on a less intensive scale. On the contrary, as already mentioned, (see page 26, supra) the recently published statistics of Sil'chenko indicate a high incidence of the disease in the Voronezh Oblast. Scanty data supplied by Jusatz (1952) point also to the appearance of a tularemia outbreak in the Tshudovo region on the Volkhov River, an affluent of Lake Ladoga. The initial manifestation of tularemia in Belorussia in 1943 has been mentioned recently by Votiakov and his associates (1960).

Maksimov (1960) stated on the authority of Novikova (1946) and Kondrashkin (1955) that tularemia attacks were reported in the Volga Delta in 1943 as well as in 1941 and 1942. As can be gathered from a second article by Novikova (1951), she proved in 1943 the presence of tularemia among the water-rats and also the domestic mice in the delta. Only 2 tularemia cases were recorded in 1943 by Borodin (1958) in the Volga-Akhtuba floodland.

As further mentioned by Maksimov, a tularemia outbreak related to the threshing of contaminated grain became manifest in the Krasnodarskii Krai in September 1943,

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1. It has to be noted in this connection that regrettably 1942 was the last year considered in the 1959 compilation of Nekipelov.

while a second wave of attacks of the disease in November and December was due to the migration of mice from the fields into the settlements.

In Western Siberia tularemia outbreaks were noted in 1943 in the Kemerovsk, Novosibirsk and Tomsk oblasts as well as according to Ogarkov and his associates (1960) for the first time in the Sverdlovsk Oblast.

Dealing with the situation in the Kemerovsk Oblast, Lebedev (1957) stressed the low incidence of the disease in man. In the 112 foci detected in this oblast from 1943 to 1949, only one attack occurred in 33, while in 62 of the foci the case incidence varied from 2-5, in eight localities from 6-9 and only in 9 from 12 to 14.

A partly water-borne and partly vector-borne outbreak in the Priobskii Raion of the Novosibirsk Oblast taking place in 1943 has been described by Karpov and his associates (1946).

Selezneva (1948) referred, without furnishing details, to water-borne tularemia outbreaks observed in 1943 in the Tomsk as well as in the Kemerovsk and Novosibirsk oblasts.

As described by Ogarkov and his co-workers (1960), a major tularemia epidemic (300 cases) occurred in 1943 in the Irbitskii Raion in the eastern part of the Sverdlovsk Oblast. As these authors maintained, though the first reported, this was presumably not the really first tularemia outbreak in that oblast.

According to a brief statement by Maksimov (1960), in the Altai Krai a tularemia outbreak was observed in 1943 in the lowland of the Charysh River and attacks of the disease were noted also in the Barnaul and two other raions. Maksimov added on the authority of Chantsova (1955) that water-rats were invariably the direct or the indirect source of these infections.

A description of a vector-borne tularemia outbreak during the period from June to October 1943 on the "K" River (apparently the Karatal River) in the Kazakhstan has been given by Bartoshevich (1948).

Attention has to be drawn finally to a considerable epidemic (234 cases in 24 localities) of water-rat origin, occurring according to Belenkov (1948) in 1943 in an unidentified oblast situated on a river and a small lake.

### Tularemia-36

1944: The scanty and no doubt incomplete material available for the year of 1944 furnished information on the occurrence of tularemia solely for four regions, the northern part of the Leningrad Oblast, the Krasnodarskii Krai, the Tomsk Oblast and Iakutia.

The outbreak in the first mentioned area, well described by Ivanov and Drobinskii (1948), though commencing in December 1944, fell rather into the following year because out of a total of 200 odd cases noted in about 15 settlements 14% occurred during June 1945, 45% in July and 17% in August, the epidemic then lingering on until December. Accordingly vector-borne infections were comparatively most frequent (53%), followed by water-borne infections (20%); the dust of contaminated hay led to infection in 12% of the attacks, while rare sources of infection were the meat of infected game (5%); food contaminated by the rodents (2%); the bite or the crushing of infected ticks (also 2%); skinning of infected rodents, washing of the eyes with contaminated water or pricking the skin with contaminated hay (1% each). The source of infection was unknown in 3% of the cases.

It is interesting to note that, besides water-rats, various mouse species and free-living R. norvegicus, also musk-rats, apparently originating from an establishment for their artificial breeding, were frequent in a part of the affected areas. The authors did not state to what extent this or the other rodent species were found infected, but came to the conclusion that tularemia was enzootic in the affected region. They actually found that three of their patients had had previous tularemia attacks during the period from 1940 to 1942.

Tularemia became apparently recrudescent in the Krasnodar Krai during the winter of 1944-1945 because Grikurov (quoted by Miasnikov and Tsareva, 1959) proved the presence of the infection in 9 hares examined at the time. To judge from a brief statement by Maksimov (1960), a murine epizootic commenced in the area in question in August 1944.

Maksimov also referred to a tularemia outbreak lasting apparently from December to January 1945 "in one of the steppe regions of the northern Caucasus."

The tularemia outbreak recorded in 1944 in the Kolpashevskii Raion of the Tomsk Oblast was noteworthy in

that, though causally related to the hunting of water-rats, it took place in October instead of in spring, as was the rule in manifestations due to this cause (Maksimov, 1960).

In the Iakutsk ASSR where, as noted before, tularemia outbreaks had occurred in 1924 and 1928, the disease became manifest once more in 1944. Summarizing the results of observations then made by Vyrlan (1948) and by Antsiferov and Pinigin (1957), Maksimov stated that in 1944 thirty-two tularemia cases were recorded from the end of July to early September, mainly in persons engaged in hay-harvesting on the islands of the Lena River. The outbreak which was no doubt vector-borne, coincided with a massive increase of the water-rat population.

1945: The continued existence of tularemia not only in the Leningrad Oblast (see Ivanov and Drobinskii, supra and also Juszat, 1952) but also in the central zone of the European part of the Soviet Union during the year 1945 is proved by the statements of several authors. Maksimov (1960) reported in the latter respect that an abundant harvest, because leading to a prolonged storage of unthreshed grain, was responsible for a mass multiplication of the mouse and vole species and the appearance of tularemia in the herds of these rodents in the Moscow, Riazan, Tambov and Voronezh oblasts and also referred to outbreaks related to the hay harvest in the Tambov Oblast. Dealing in particular with the Moscow Oblast, Tsareva mentioned a water-borne tularemia epidemic taking place in April 1945 in the Malinskii Raion (apparently 15 cases). As stated by Miasnikov and Tsareva (1959), the presence of the infection among the hares of that oblast was proved for the first time. That during the period under review the tularemia situation in the Moscow Oblast was apt to become serious, is shown by a brief remark of these two authors according to which the case incidence of the disease in the two years of 1945 and 1950 amounted to 1,520.

Isakov (1947), dealing with the 1945 epizootic in the Riazan Oblast, mentioned the interesting fact that only Microtus arvalis and Mus musculus were involved while the herds of Apodemus agrarius were apparently not affected.

The high incidence of tularemia in the Voronezh Oblast in 1945 has been mentioned already (see page 26, supra). It would seem that the tularemia epizootics then prevailing in that oblast were described by Nekipelov (1946), even though this author in his text merely referred to observations on the river "S."

### Tularemia-38

While according to Borodin (1958) in 1945 as well as in the preceding year no information on the occurrence of tularemia in the Volga-Akhtuba floodlands was available, the presence of the disease in the Volga Delta was recorded by Novikova (1951). According to Pilipenko (1953), quoted by Sil'chenko (1962), an intense epizootic among the water-rats was raging there in 1945 to 1946.

Referring to an interesting manifestation in Turkmenia, Maksimov (1960) summarized that

"E. IA. Shchegolova (1957)<sup>1</sup> described a tularemia outbreak in the town of Tashauz in 1945-1947, which was characterized mainly by bubonic and anginose-bubonic attacks. The outbreak involved mainly persons occupied with the manufacture of string from cotton-wool, which had been kept in stacks for many years. In other cases possible sources of infection were food products and drinking water contaminated by mice. The author remarks that phenomena preceding the tularemia outbreak in Tashauz were (a) good grain harvests from 1942-1945 which were gathered with delay; (b) a high flood in the environs of the town in 1944 and in connection with this an abundance of Mus musculus in the houses in the autumn of that year. In the focus 8 tularemia cultures were isolated - five from house-mice, two from Nesokia indica (which speaks for a connection of this focus with the floodland of the Amu-Darya [see also: Dunaeva, 1953]).<sup>2</sup> One culture each was isolated from a rabbit, respectively a grey hamster."

1946: Records for the reappearance of tularemia outbreaks in the formerly affected areas in the European part of the Soviet Union in 1946 are available only in the case of the Moscow, Tula and Voronezh oblasts.

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1. According to Olsuf'ev and Rudnev, Shchegolova's paper was published in 1958.
  2. The possible role of Nesokia indica in the epidemiology of tularemia in the floodlands of the Amu-Darya was also discussed in a second report by Shchegolova.

In the Moscow Oblast, according to Tsareva (1959), a water-borne epidemic, involving 14 persons, was observed in the Lugovoi station, while Olsuf'ev (1947) recorded the detection of tularemia-infected ticks in the Mikhnevskii raion. It also deserves attention that Slavin, in a thesis published in 1946, described tularemia outbreaks in the Moscow Oblast due to epizootics among hares.

The occurrence of tularemia attacks contracted from hares in the Tula Oblast in 1946 (and again in 1949) was briefly mentioned by Miasnikov and Tsareva (1959).

The 1946 incidence of the disease in the Povorinskii Raion of the Voronezh Oblast amounted according to Sil'chenko to 347 cases.

It was not possible to establish the location and time of occurrence of the vector-borne outbreak described by Feshchenko and Protopopova (1946) which, according to Maksimov's book, also took place in the central zone of the European part of the Soviet Union.

As recorded by Miasnikov and Tsareva (1959), in the autumn of 1946 a massive multiplication of the mouse species and hares as well as a considerable mortality among the latter were noted in the Kaliningrad Oblast in the northwest of the European part of the Soviet Union. The tularemic nature of this epizootic was confirmed through the appearance of the disease in the population of the oblast. Observations made in only four of the affected raions showed an incidence of 257 cases, more than half of these attacks (154) being due to infections contracted from the eagerly hunted hares.

In the Volga-Akhtuba floodlands 593 tularemia attacks were recorded from April to September 1946. As shown in a table inserted in Borodin's report (1958), 268 of these cases were noted in the Leninskii Raion and 321 in the Sredne - Akhtubinskii Raion. A careful study led this observer to the conclusion that the 1946 outbreak was causally related in part to the hunting of water-rats, but was mainly vector-borne.

The occurrence of a tularemia epizootic, involving also the hares, during 1946-1947 in the Stavropol Krai has been briefly mentioned by Miasnikov and Tsareva.

Though the summary by Isakov and Sazonova (1946) quoted above implies a continued existence of tularemia in

#### Tularemia-40

Western Siberia, no information in point referring particularly to the year 1946 could be found in this or any other publication.

Maksimov (1960), quoting an article by Kir'ianov (1957) not available to the present reviewer, stated that the tularemia epizootics in the Altai Krai became increasingly more frequent from 1946 to 1950.

Though, as maintained in a recent article by Kraft (1952), presumably unrecognized tularemia attacks had occurred earlier in the former Akmolinsk district of Kazakhstan, the presence of the disease in that area was first confirmed in 1946, when 222 cases were recorded--8 in Akmolinsk, 136 in the raion of the same name and 78 in the Kurgal'dzhinskii Raion. Further reference to that area will be made in the following sections of this report.

As stated by Antsiferov and Pinigin (1957), 10 rather severe attacks of tularemia were recorded in 1946 in the Iakutsk Raion (as against 2 in 1945) and about 180 cases in the Ordzhonikidzevskii Raion of the Iakutsk Oblast, all at the end of July or in early August. The latter epidemic was causally related to a water-rat epizootic in the affected raion and adjacent islands of the Lena River which had started already in 1945. However, the season of the outbreak and the preponderance of ulcero-bubonic attacks left no room for doubt that this as well as the previous outbreak in Iakutia was vector-borne.

For the convenience of record it is added that in July-August 1947 thirteen attacks of the bubonic form of tularemia were observed by Antsiferov and Pinigin in persons harvesting hay on an island in the Lena River and an adjacent locality. This was obviously also a vector-borne outbreak.

1947: Information on the occurrence of tularemia during the year of 1947 in the European part of the Soviet Union is available for the following regions:

- (a) Tsareva (1959) noted that in January-February 1947 four inhabitants of a village in the Naro-Fominskii Raion of the Moscow Oblast, who in contrast to the large majority of the population had not been vaccinated against tularemia, contracted the infection.

- (b) As recorded by Miasnikov and Tsareva (1959), in the autumn and early winter of the year under review 163 tularemia cases were noted in two raions of the Kaliningrad Oblast. Most of these infections were related to agricultural operations or were contracted from the intradomestic rodent fauna, only 21 of the patients having had contact with hares.<sup>1</sup>

The two just mentioned observers referred also to a not further identified report by Shmuter on five familial tularemia outbreaks occurring in 1947 respectively in three oblasts of the Ukraine and in the Odessa Oblast, which all were causally related to the cutting up and the consumption of hares. It is interesting that two out of the 19 patients concerned succumbed to the infection.

- (c) The occurrence of tularemia in the Volga Delta in 1947 was recorded by Novikova (1951). In contrast to 1946, the number of tularemia attacks in the Volga-Akhtuba floodlands remained quite low during the period from 1947 to 1950 (1 case respectively in 1947 and 1948, 6 in 1949 and 5 in 1950) (Borodin, 1958).

As can be gathered from the data assiduously collected by Maksimov (1960), the first signs of an ominous increase in the number of the water-rats in Western Siberia, followed by tularemia epizootics among these animals and human manifestations of the disease were noted in the autumn of 1947 in the Novosibirsk, Omsk, Tiumen and Kurgan oblasts. The most serious consequences of this recrudescence of the infection will be described in the following section of this report.

In a 1959 paper, which evidently had not yet been available to Maksimov, Kuzina stated that tularemia outbreaks due to water-rat epizootics, but mainly of a water-borne type, began to appear at the same time in the Kemerov Oblast of Western Siberia, 66 human attacks of the disease being recorded in 1947.

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1. A second 1959 publication on tularemia in the Kaliningrad Oblast by Shushkevich and Tokarevich was not available to the present reviewer.



#### Tularemia-42

Statistics furnished by Kraft indicate that in 1947 fifty-nine tularemia cases were noted in the Kurgal'dzhinskii Raion of the former Akmolinsk Oblast in Kazakhstan. While the manifestations of the disease met with the hunting of water-rats or were vector-borne, the 1947 epidemic was of a water-borne type (Maksimov, 1960).

As noted above (see the account for 1946), 13 tularemia cases were noted in 1947 in Iakutia.

1948: That, as maintained in a general manner by Zhdanov (1956), the incidence of tularemia in the Soviet Union showed a most marked increase in 1948, is confirmed by the following reports:

As stated by Sil'chenko (1962), tularemia manifestations were during that year widespread and severe in the Voronezh Oblast.

Attention was drawn by Olsuf'ev and Rudnev to the occurrence of massive outbreaks of the disease in the Ukraine and Moldavia. It is important to add that Shmuter (1959) recorded a particularly frequent and often quite serious appearance of tularemia among the workers in many of the sugar factories of the Ukraine and also of the adjacent oblasts.

As stated by Shmuter, the occurrence of tularemia attacks in sugar factories was first noted in 1946 in the Voronezh, Kursk and Poltavsk oblasts, but the incidence of the disease was then inconsiderable. However, the massive increase of the mouse-like rodents, particularly of the common voles, taking place in the autumn of 1948 in many of the sugarbeet-growing raions of the Ukraine (and also in the Kursk and Voronezh oblasts) and the resulting tularemia epizootics created a most serious situation, leading to mass attacks in the human population, including the workers in many sugar factories, during the winter of 1948-1949. Shmuter found in this connection that the sugar factories in the Ukraine and in the adjacent sugar-producing oblasts could be divided into the following groups:

1. Plants situated in tularemia-free raions and also receiving sugar-beets from not affected localities and therefore remaining free from the disease;

2. Factories located in tularemia-affected raions or receiving their beets from such raions, but

completing their work before the epizootics had become widely spread. In such establishments there occurred only few attacks of the disease or even none at all;

3. Plants situated in tularemia-free raions but receiving their raw material from affected raions. In such cases tularemia outbreaks became manifest only among the factory workers, the other part of the population remaining unharmed;

4. Factories in raions in which at the time of sugar-production tularemia was active. Though in these areas besides the workers also other people contracted the disease, the former suffered more than the latter.

In the factories the incidence of tularemia was heaviest among the workers handling the beets before they had been subjected to treatment by heat. As maintained by Shmuter, the appearance of the disease among the workmen was mainly the result of a droplet infection, the vehicle of which was the water used repeatedly for washing the sugar-beets. However, an introduction of the tularemia bacilli into the mouth through contaminated hands was probably also of importance. Certain is that 96-100% of the affected workers showed a localization of the infection in the internal organs, particularly in the respiratory tract. It is important to add that the causative organisms could be isolated from the untreated beets, the water used for their washing and also from the half-finished yellow sugar.

The 1948 tularemia outbreak in the Adamovskii Raion of the Orenburg Oblast described by Volkova and Iushkin (1961) though involving only 6 persons, is of interest because all the attacks were causally related to an epizootic among musk-rats recently imported for the purpose of acclimatization. For the convenience of record it is added that, while the Adamovskii Raion afterwards remained free from the infection, subsequent tularemia manifestations were observed in 3 other raions of the oblast, namely in the Krasnokholmsk Raion in 1949 (3 cases), the Mustaevsk Raion (30 cases in 1950, 6 in 1951, 2 in 1952 and 12 in 1958) and in the Ilekskii Raion (affected in 1928 and 1929) in 1951 and 1959 (one case each). Volkova and Iushkin concluded that water-rats functioned as the tularemia reservoir in these localities and expressed the belief that a focus of the infection had continued to exist in the oblast for 30 years.

#### Tularemia-44

Turning attention to the tularemia situation in Western Siberia, it is proposed to deal for the convenience of record not only with the year of 1948 but also with the next following years. As can be gathered from the publications of Ravdonikas (1952), Alifanov (1954), Filippova (1956), Kuzina (1959), Ogarkov and associates (1960) as well as from the summaries of Maksimov (1960), serious manifestations of the disease were observed during this period in the Novosibirsk, Omsk, Kurgan and Kemerovsk oblasts, all causally related to epizootics in the extraordinarily increased herds of the water-rats. It is of great interest to note in this connection that, as described by Maksimov, in contrast to the river valleys where these animals were decimated by short-lasting epizootics, in the foci of Western Siberia long-lasting epizootics were frequent. Thus, quoting the Kyshtovskii Raion of the Novosibirsk Oblast as an example, Maksimov stated that

"The first signs of a tularemia epizootic appeared in 1947 in the south-western part of this raion. However, after one year, in the autumn of 1948, the number of water-rats was not only not lowered, but a noticeable increase of their herds could be observed. The preparation of the furs of the animals in that year was greatly increased. In the autumn of 1948 the hunters got in their enclosures very many of these rodents in places where in the previous year the animals had been observed to die...."

As Maksimov continued, a high mortality of the water-rats was observed in the various affected parts of the oblast only in 1949, 1950 or even 1951. As a result of these prolonged epizootics the epidemics also ran a protracted course. Thus, according to Ravdonikas, during the period from 1947 to 1951 fifteen settlements were observed in the Omsk Oblast where tularemia manifestations in man were noted for three successive years, and in two localities attacks continued for four successive years.

The information available in regard to the incidence of tularemia in the individual oblasts mentioned above may thus be summarized:

As stated by Maksimov, during the period from 1947 to 1949 the disease was four times more frequent in the Novosibirsk Oblast than had been the case from 1937 to

1939, when the numbers of the water-rats had also been greatly increased. Most severely affected were the Barabinsk raions, where 94.1% of all tularemia attacks in the oblast were noted in 1948, 88.1% in 1949 and 71.5% in 1950.

According to Filippova (1956), during the period from 1948 to 1953 61.2% of the tularemia attacks in the most severely affected parts of the Novosibirsk Oblast were due to a vector-borne infection, 36% to water-borne infections, while only less than 1% were causally related to the hunting of water-rats. The corresponding figures for the Kulundunskii group of raions were 45%, 32% and 11%, 12% of the attacks being due to other causes.

Statistics for the Omsk Oblast quoted by Maksimov showed that vector-borne infections preponderated in 1948 (74%), became less frequent (50.8%) in 1949, but again became very numerous in 1950 (82%). Figures available only for 1949 indicate the occurrence of water-borne infections in 38.8% and a causal connection with the hunting of water-rats in 10.4%.

As can be gathered from the instructive article by Ogarkov and his associates (1960), the incidence of tularemia in the Kurgan Oblast amounted in 1948 to 5.53 per 10,000 population, while the corresponding figure for 1949 was 4.95. The authors added that in the latter year a high incidence of the disease was noted in the Sverdlovsk Oblast (3.43 per 10,000 population).

According to Kuzina (1959) the case incidence of tularemia in the Kemerovo Oblast was 208 in 1948, 539 in 1949, 198 in 1950 and 142 in 1951. 20 subdistricts were affected by the disease in 1949.

The occurrence of mostly water-borne tularemia attacks in the Starobardinskii Raion of the Altai-Krai in 1948 and also in the subsequent years was recorded by Olsuf'ev and his co-workers (1959).

1949: Apart from Western Siberia, already dealt with above,<sup>1</sup> the following tularemia manifestations were reported in the Soviet Union during the year of 1949:

1. It has to be added that according to Karpov and his co-workers (1958, 1959) in connection with an epizootic among water-rats and Microtus oeconomus sporadic tularemia attacks were observed in May 1949 among water-rat hunters in the Molchanovskii Raion of the Tomsk Oblast.

#### Tularemia-46

The occurrence of 37 attacks of the disease during January and February of that year near the town of Serpukhova in the Moscow Oblast was mentioned by Tsareva (1959).

Nefedov (1960), dealing with the tularemia problem in the Kliazma Basin, reported 1949 manifestations of the disease in (a) the Gorovedskii Raion (5 vector-borne attacks); (b) the Viazinovskii Raion of the Vladimir Oblast (5 cases observed in October in a family of water-rat hunters); and (c) the IUr'evopol'shii Raion, where 52 persons became involved in an epidemic causally related to the delayed threshing of grain. A considerable vector-borne outbreak (95 cases) occurred in the summer of 1950 in the Kovrovskii Raion of the Vladimir Oblast. Subsequent tularemia manifestations in the Kliazma Basin will be dealt with in the following section of this review.

As stated by Sil'chenko (1962), tularemia continued to be widely spread in the Voronezh Oblast in 1949, when 62 cases were noted in the Povorinskii Raion as against 10 in 1948.

According to Dobrianin and Shishkalov (1960), the case incidence of tularemia in the Brest Oblast of Belorussia was 4 in 1949, 2 in 1950 and 4 in 1951.

Zeigermacher (1954) referred in a brief note to the appearance of tularemia in a south-western district of the Ukraine during the winter of 1949, 98% of the patients seen there (all adult members of the rural population) suffered from the visceral form of the disease. Their infection was thought to be due to the handling of contaminated objects like straw, dried maize stalks and dried sunflowers used for fuel.

In a report evaluating the efficacy of tularemia vaccination in the construction zone of the Stalingrad hydroelectric station, Borodin (1958) recorded the following data for the Volga-Akhtuba floodlands:

<u>Year</u>	<u>Number of Tularemia Attacks</u>	<u>Vaccinations per year</u>	<u>Aggregate Total of Vaccinations</u>
1946	593	11,622	11,622
1947	1	4,377	15,999
1948	1	4,054	20,053
1949	6	6,465	26,518
1950	5	5,181	31,699

N. B. Tularemia was absent from 1951 to 1954. The aggregate number of vaccinations in the latter year was 81,739.

In their important article on tularemia in the regions of the Ural and its foothills already quoted above, Ogarkov and his associates (1960) reported that in 1949 the incidence of the disease per 10,000 population was 1.95 in the Perm Oblast and 1.08 in the Udmartskaia ASSR.

It has to be added that Rubina (1947), in a report quoted by Miasnikov and Tsareva (1959) and by Maksimov (1960), referred to the presence of a major tularemia epizootic among the mice in one raion of the Perm Oblast during the winter of 1949-1950. A transition of the infection to the hares led to the appearance of the disease in four persons in 1950. It is noteworthy that the presence of tularemia in the area also led to a high mortality among the cats.

As recorded by Kraft (1962), 30 tularemia attacks were noted in 1949 in the former Akmolinsk Oblast, mostly in the raion of the same name (19 cases).

Amplly discussing the great progress in tularemia research during the period presently under review, Olsuf'ev and Rudnev (1960) laid particular stress upon the studies on the epidemiology and control of the disease made during the war and upon the pioneer work in the field of immunology by El'bert and Gaiskii which led to the introduction of an effective system of anti-tularemia vaccination--a subject which will be fully discussed in Part II of the present review.

#### 5. Period from 1950 to the present

In order to give as clear a picture as possible of the recent tularemia situation in the Soviet Union, it seems well, instead of dealing as heretofore with the history of the disease year by year, to render after a general introduction accounts for each of the still affected regions.

Discussing the geographical distribution of tularemia and the main features of the ecology of the disease in the Soviet Union, Olsuf'ev and Rudnev (1960) stated that

"At present tularemia is observed in the territory of 11 of the allied republics (Russian SFSR and the Ukrainian, Belorussian, Moldavian, Esthonian, Latvian, Grusinian, Armenian, Azerbaidzhan, Turkmenian and Kazakh SSR) and has not been detected in 4 republics (Lithuanian, Uzbek, Tadzhik and Kirghiz). The occurrence

#### Tularemia-48

of natural tularemia foci has been established from the western border of the USSR (Kola Peninsula, Karelia, the Baltic Shore, the Kaliningrad Oblast, the west of Belorussia, the Ukraine and Moldavia) to IAKutia and the Khabarovsk Krai in the east. In the north tularemia foci are found in places up to the polar circle and partly even beyond this (Kola Peninsula, the Pechora Lowlands, Igarka on the Enisei, Zhigansk on the Lena), whereas in the south they are met with in the Crimea, the Transcaucasus and some republics of Central Asia."

According to Olsuf'ev and Rudnev within this wide area the following types of natural tularemia foci are met with:

1. The meadow-field type, first defined by Maksimov (1946) and described in detail after a study of the foci in the south of the Moscow Oblast by Olsuf'ev (1947). The main reservoir of tularemia there is Microtus arvalis, but other small mammalian species like Sorex araneus and hares are also apt to become involved in the epizootics, while the tick Dermacentor pictus plays a most important role not only as the principal vector of the infection but also by carrying it over during the interepizootic periods. Characteristic for this type of foci are winter outbreaks related to agricultural activities and also water-borne epidemics due to a contamination of wells. As Olsuf'ev and Rudnev summarized,

"The foci of the meadow-field type are distributed in the central zone of the European part of the USSR, extending towards the north-east to the Leningrad Oblast (where D. pictus is replaced by Ixodes ricinus) and towards the southwest to the Ukraine. In the part of Western Siberia with forest-steppes there exists probably a variant or analogon to this type of focus where the common field-vole is replaced by Stenocranius gregalis...."

2. The steppe (ravine) type, also defined by Maksimov (1946), who proposed for it the name of "murine" type, and studied by Borodin and associates (1959) and other workers. According to Olsuf'ev and Rudnev numerous hosts are involved in the tularemia foci of this type, including, besides the common voles, hamsters, in places hares, steppe

lemmings and various mice. Mus musculus seems to be of secondary importance in the maintenance of the infection but, if becoming extraordinarily numerous during "mouse years," may play a predominant role in the spread of the infection.

Most important among the ticks conveying and also preserving the infection is Dermacentor marginatus, but in some of the foci an auxiliary role may be played by various other species including Rhipicephalus rossicus, Ixodes laguri and probably gamasidae of the family Dermanyssidae.

While in summer tularemia remains sporadic among the host animals or causes only small epizootics, the latter become intense in autumn and winter among the common voles and house mice. As far as the manifestations of the disease in man are concerned, characteristic for the foci of this type are intradomestic outbreaks, related to agricultural operations and in part also water-borne epidemics.

Foci of the steppe or ravine type are distributed in the south of the European part of the Soviet Union, including Moldavia, the Ukraine, the lower Povolzh'e, the northern Caucasus, presumably also in a modified form in the steppes of the West-Siberian lowlands.

3. Forest type, defined by Olsuf'ev (1947), where the main tularemia reservoirs appear to be the red vole Clethrionomys glareolus, the forest mouse Apodemus silvaticus and, if numerous, also hares. Most important among the tick vectors is Ixodes ricinus, but in some localities Ixodes trianguliceps is also of importance. Human infections in these foci are apt to be causally related to the hunting of hares or the bites of ticks. In western Europe the first mentioned factor seems to be of principal importance.

4. Floodland-swamp type, defined by Maksimov (1946) and amply studied by several subsequent observers. Here the principal reservoir of the infection are the water-rats (Arvicola terrestris) but in the different foci of this type various other mammals may become involved in the epizootics, such as the common voles, Microtus oeconomus, musk-rats and hares. Various tick species of the genera Dermacentor, Rhipicephalus and Ixodes are instrumental both in conveying and carrying over the infection and presumably an analogous role is played by gamasidae. In summer the infection is widely spread among the water-rats by mosquitoes. Human outbreaks, the fundamental source of which are the water-rats, may be related to the hunting of these animals, be vector-borne or partly water-borne.



## Tularemia-50

Referring to the geographical distribution of this type of foci, Olsuf'ev and Rudnev stressed that, in contrast to the types considered above, the floodland-swamp foci, being located in the floodlands and deltas of rivers, the marshy shores of lakes and in swamps, show an interzonal distribution, occurring in almost the entire territory of the European part of the Soviet Union and of the West-Siberian lowlands, and in some places also in eastern Siberia.

5. Foothill-brook type, first described by Bozhenko (1950) but named by Olsuf'ev and his associates (1959) and amply studied also by other workers quoted in Olsuf'ev and Rudnev's book. While here also the water-rats are the main reservoir of the infection, the common voles and other species highly sensitive to tularemia are apt to become involved in the epizootics. Most characteristic among the ticks playing a role in this type of foci is Ixodes apronophorus. Peculiar to these foci is a contamination of the brooks during the summer, due mainly to diseased water-rats among which tularemia is rampant in that season. Infections in man, usually appearing at the same time, are mainly water-borne.

Foci of this type are localized in the Kuznetskii Alatau, the Altai, the western Saian, the Tarbagatai, the eastern Tian'-shan and in the Caucasus (Maikop), presumably also in Armenia and Azerbaidzhan.

6. "Tugai"<sup>1</sup> type, defined by Kondrashkin (1957) who rather infelicitiously called the pockets of tularemia infection in point "desert-floodland foci." This type of tularemic foci has been met with so far on the middle course of the Chu River (Kazakh SSR), in the lowlands of the Ili River (also in the Kazakhstan) and of the Amu-Dar'ia (Tashauz), and also in the delta of the Syr-Dar'ia. In these little investigated foci the presence of tularemia has been demonstrated in Lepus tolai, the gerbil Meriones tamariscinus,<sup>2</sup> house-mice and musk-rats as well as in the tick Rhipicephalus pumilio. The sporadic attacks of the disease in man usual in these foci appear mainly in hunters, rarely in other persons.

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1. "Tugai" is the name for the growths of low trees and shrubs in the valleys of desert rivers.
  2. Though the correct name of this rodent ought to be M. tamaricinus (from tamarix, tamaricis), the misspelt version "tamariscinus" has been generally adopted.

The by no means complete information on the recent incidence of tularemia in the individual regions of the Soviet Union may thus be summarized:

European part of the Soviet Union

- (a) Western areas. - Though according to the above quoted statements of Olsuf'ev and Rudnev several regions in the westernmost part of the Soviet Union continue to be tularemia-infected, only partial and quite scanty pertinent information is available, i.e., with the exception of the Kola Peninsula (Murmansk Oblast) in the extreme north, only for the Esthonian SSR, the Leningrad Oblast, Belorussia and the Ukraine.

According to an article published in 1957 by Troparev and his associates, the history of the tularemia outbreak observed by them on the Kola Peninsula early in 1955 goes back to December of the preceding year, when in a small settlement on a river near the sea attacks of a febrile disease with pains in the throat were observed. Three more persons, who fell ill in January 1955 were hospitalized in March when they showed suppurated cervical buboes and a positive tularin reaction. 14 more patients, suffering mostly from the anginose-bubonic form of tularemia, were treated at home. Apparently their infection was water-borne.

As can be gathered from the article under review, in 1953 and 1954 a great increase of the field voles (Clethrionomys rufocanus) and lemmings (Lemmus lemmus) was observed in the affected region. This increase reached a maximum in the autumn of the latter year. During the period from August to October 1954 a mass migration of the lemmings took place. This was accompanied by a high mortality in their herds. The voles evidently became involved in this epizootic since subsequently their numbers were found to have greatly decreased. Though it was not possible to subject the affected animals to a laboratory examination, there can be no doubt that they suffered from tularemia.

As quoted by Maksimov, Zhelnin and Kozlov, in a paper published in 1956, reported on an epizootic among hares (L. europaeus) on one of the islands of the Esthonian SSR, which they considered to be due to tularemia, because at the same time attacks of the disease

## Tularemia-52

due to bites of Ixodes ricinus became manifest among the human population. A more recent paper on tularemia in Esthonia by Medinskii and co-workers (1959) is known by title only.

Articles published by Ivanova-Kleush et al. in 1957 and by Ul'ianova and associates in 1959 referring to the presence of natural tularemia foci in the Leningrad Oblast, specifically to a vector-borne tularemia outbreak in the Vyborg Raion of this oblast also were not available to the present reviewer.

It is fortunate that the ample but mostly inaccessible literature dealing with the recent tularemia situation in Belorussia<sup>1</sup> has been copiously quoted by Maksimov (1960) and ably summarized by Votikov and his colleagues (1960), thus:

"At the present time the circulation of the tularemia bacilli in the natural foci can be described as follows: Besides the water-rats there are involved in this circulation Microtus oeconomus and the common "kutora" (Neomys fodiens--also a shrew). The presence of the infection has been demonstrated in the mosquitoes Aedes excrucians, cinereus, vexans and bifurcatus, the horse-fly Chrysozona pluvialis, the ticks Ixodes ricinus and Dermacentor pictus. The isolation of tularemia bacilli from gammaside ticks and rodent nests also deserves attention. The organisms have been isolated from water, rapacious water-beetles and water-birds (Gallinula chloropus).

Human attacks appear at the time of a coincidence of several factors--epizootics among the water-rats, the flight of blood-sucking diptera and visits to the natural foci by the people (a vector-borne type of infection has been reported

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1. See particularly the papers by Adamovich (1958); Dobrianin and Shishkalov (1960); Guзов (1959); Rubanova (1955, 1957); Rubanova and Senchuk (1957, 1958); Senchuk et al. (1957 a, b); Vapnik and Senchuk (1957); Votikov et al. (1960) and Zakovich (1957).

in Belorussia in 68.3% of the cases) or epizootics among the water-rats and other animals, abundant rains and hay-harvesting. Attacks related to water contaminated by the carcasses of (tularemia-) affected animals are observed in 22.8%. Other routes of infection are of lesser epidemiological importance."<sup>1</sup>

As Votiakov and his co-workers continued, the disease affected mainly the rural population (76.2%) in connection with work in the natural foci. Tularemia was most frequent in the Gomel' Oblast (48.1%), next in the Minsk and Brest oblasts (18.6%, respectively 13.5%) and in the Vitebsk Oblast (13.4%). In some of the raions the tularemia morbidity was high (48.2 per mille). Natural foci were less numerous in the Mogilevsk and Grodnensk oblasts, where 90% of the raions had never been affected by the disease.

According to the statistics of Dobrianin and Shishkalov (1960), after an apparent absence during the period from 1952 to 1954, tularemia attacks in the Brest Oblast numbered 167 in 1955, 109 in 1956, 4 in 1957 and 40 in 1958. No cases were recorded in 1959.

Another recent manifestations of the disease in Belorussia was the apparently vector-borne 1958 outbreak in 4 villages of the Parichkii Raion near the Berezina, in the course of which 11 bubonic attacks were observed (Guzov, 1959).

Reporting in 1960 on results of a study on infectious diseases showing an occurrence in natural foci, Zavadovskii and his co-workers stated that

"The extraordinarily wide spread of tularemia in the territory of the western oblasts of the Ukraine is a long established fact. Particularly affected by the disease are the Rovenskaia, Volynskaia and also the Vinnitskaia oblasts. The numerous tularemia foci existing in many raions of these oblasts

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1. The fact, however, that outbreaks related to tularemia epizootics among hares have been recorded, e.g. by Adamovich (1958) and by Rubanova and Senchuk (1957), merits attention.

#### Tularemia-54

become periodically active and as a result a mass morbidity is observed among the population. The fundamental reservoirs of tularemia in the western part of the Ukraine are the water-rats and the pasture ticks from which the infection is transmitted to the species of field-mice. The transition of the infection to man is effected mainly through contact with the rodents and by insect vectors. The bulk of the infections takes place at the time of the hay harvests and the work in the fields. The considerable tularemia outbreaks observed from 1954 to 1956 in the Rovenskaia and Volynskaia oblasts and also in a southern raion of the Zhitomir Oblast were manifest in the ulcero-bubonic form with predilection for an affection of the upper extremities.

This observations permits the assumption that at the present the most actual routes of infection are by insects and partly by water (?).

The periodic appearance (up to recent times) of large tularemia outbreaks<sup>1</sup> necessitates serious attention being paid to this disease...."

In view of this statement it is somewhat surprising to find in a 1961 article by Leshchenko and his co-workers the assertion that tularemia no longer exists in the Ukraine. It is true, however, that, as mentioned by these authors, 2.8 million anti-tularemia vaccinations had been administered to the local population.

Pushkarenko (1962), in a report on a recent conference on zoonoses held in Odessa analogously stated that tularemia had been absent in the Ukraine during 1960. However, as seems to be implied in this report, natural foci of the infection still continue to exist in the area.

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1. Such an outbreak was evidently noted by Slesarenko and his colleagues in a 1959 report not available to the present reviewer.

- (b) Central zone. - The information available in regard to recent tularemia manifestations in the central zone of the European part of the Soviet Union may thus be tabulated:

<u>Oblast or Area</u>	<u>Observations</u>
Chuvash ASSR	As stated in a recent publication by Timofeev and Andronnikov (1962), in order to confirm the apparent absence of tularemia from the Chuvash ASSR (situated in the central zone of the European part of the SFSR in the middle Volga valley), a representative group of 11,000 inhabitants of rural areas (= 1% of the population) was subjected to cutaneous tularin tests. Positive results were obtained in 33 instances only and it appeared, moreover, that only 11 of the reactors had contracted the infection within the confines of the republic.
Ivanov and adjacent oblasts (Kliazma Basin)	According to Nefedov (1960), whose earlier observations have been quoted already in the preceding section of this review (see pp. 32 and 46 <u>supra</u> ) during the period from 1951 to 1956 tularemia showed only a sporadic incidence in the Ivanov and adjacent oblasts in the basin of the Kliazma River. However, in 1957 there is a record of a widespread epidemic which involved 206 settlements in 7 raions of the Ivanov Oblast, 4 raions in the Vladimir Oblast; moreover 5 cases related to this outbreak were noted in the Gor'ki Oblast and 2 attacks in Moscow. The total case incidence during the epidemic, which lasted from June to September, was 1,044, 625 of the attacks being noted in August. 75.4% of the patients showed signs of ulcero-bubonic affections.

Nefedov came to the conclusion that

"the fundamental role in the development of the 1957 outbreak was played by the following epidemiologic factors: the presence of elementary (tularemia) foci in the territories not subjected to floods, and considerable increase of the number of water-rats in 1956-1957 and their concentration in the

## Tularemia-56

### Oblast or Area

### Observations

elementary foci at the time of the spring floods, the rapid fall of the flood and the drying-out of the usual habitats of the water-rats, which led to a migration of the animals to new sites, thus intensifying the circulation of the infection. An abundance of vectors (mosquitoes and horse-flies) insured a transmission of tularemia from rodent to rodent and also from the rodents to persons coming to the floodlands for the purpose of hay-harvesting."<sup>1</sup>

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Kaluga and  
Kostroma  
oblasts

In a study on the virulence of the B. tularensis strains isolated in the Soviet Union, Tereshchenko (1959) mentioned the occurrence of tularemia epizootics among voles in the Kaluga Oblast in February 1957 and in the Kostroma Oblast in March of the same year.

A report on a winter outbreak of tularemia, related to the delayed threshing of rye on a farm in the Kostroma Oblast and involving 16 out of 31 persons taking part in this work, has been published in 1960 by Uglovoi. The year when this epidemic took place (? 1958) is not stated. Evidently two sporadic tularemia attacks had occurred in the affected raion in 1943.

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Moscow Oblast

In her 1959 article on water-borne tularemia outbreaks in the Moscow Oblast already quoted above, Tsareva (1959) stated that the introduction of anti-tularemia vaccination led to a rapid decline in the incidence of the disease. She recorded that (a) during the period from December 1952 to January 1953 seven non-vaccinated persons fell ill in the

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1. A 1959 paper by Latsis, dealing with the clinical and epidemiological features of tularemia in the Viaznikov sanitary sector, Vladimir Oblast, was not available for review.

Oblast or Area

Observations

Kolomna Raion after the consumption of tularemia-infected water and (b) in April 1954 out of 100 persons who had used tularemia-contaminated water on a collective farm in the Mozhaisk Raion, where no tularemia vaccinations had been given, 18 contracted the infection. Tsareva added that this was the last water-borne tularemia outbreak observed by her in the oblast.

It has to be added that articles dealing with epizootics among the common voles in the Moscow Oblast have been published in 1955 by Olsuf'ev and his assistants as well as by Rubina and her associates.

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Smolensk  
Oblast

Writing in 1955, Sorina stated that, though since 1946 no tularemia epidemics had occurred in the Smolensk Oblast, still sporadic attacks of the disease were observed almost every year.

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Tula Oblast

Referring to the Tula Oblast, Maksimov (1960) declared that

"Notwithstanding the fact, according to the data of IU. A. Miasnikov (1955), the water-rat is observed there on all rivers and streamlets, and also on the shores of artificial waterways, in contrast to the floodlands of the major rivers in other oblasts, this animal has no considerable colonies. According to these data, no tularemia attacks have been observed in the river floodlands of the Tula Oblast, since the water-rat is not hunted there and cannot infect the diptera vectors."

Attention should be given, however, to the fact that Miasnikov and Tsareva (1959) mentioned that (a) in 1951-1952 186 tularemia cases had been noted in the oblast; and (b) in 1954-1955 a bacteriologically confirmed tularemia epizootic among the common voles had been observed within that area.

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## Tularemia-58

### Oblast or Area

### Observations

Voronezh  
Oblast

In his 1961 article, already quoted, Sil'chenko distinguished three periods in the ecology of tularemia in the Voronezh Oblast,<sup>1</sup> namely (1) the period lasting from 1930 to 1938, during which a few outbreaks due either to a professional contact with water-rats or of a vector-borne nature were observed; (2) the years from 1939-1949, during which a new type of the disease became manifest, outbreaks due to infection from mice and occurring in autumn and winter on the farms and in the houses, followed during the warm season by large vector-borne epidemics among the people living in the floodland foci of tularemia; and (c) a final period from 1950-1959, characterized by the absence of the murine type of the infection (brought about by the introduction of modern agricultural methods) and consequently a marked decrease in the incidence of human attacks. However, sporadic manifestations of the disease continued to be present every summer. According to the statistics of Sil'chenko (1962), the case incidence in the Povorinskii Raion was 5 in 1950, 4 in 1951, 3 in 1952, 1 in 1953, nil in 1954-1956, 2 in 1957, nil in 1958-1959 and 1 in 1960. Tularemia infected water-rats were still found during the last mentioned year.

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- (c) Don Delta. - In an article describing the tularemia situation in the Don Delta, Bozhenko (1957) furnished the following data on rodents and other small mammals found naturally infected with B. tularensis during the period from 1949 to 1955:

(see table on page 59)

As shown in a second table, an examination of 5,595 water-rats during the period from 1947 to 1954 yielded 92 tularemia cultures.

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1. This problem has also been dealt with in a short 1958 article by Riabich.

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<u>Species</u>	<u>1949</u>	<u>1950</u>	<u>1952</u>	<u>1953</u>	<u>1954</u>	<u>1955</u>
Water-rats	+	+	+	+	+	+
Common voles	+	-	+	+	-	-
<u>M. musculus</u>	+	-	+	-	-	-
<u>Apodemus silvaticus</u>	-	+	-	+	-	-
<u>R. norvegicus</u>	+	-	-	-	-	-
<u>Sorex araneus</u>	-	-	-	+	-	-

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Because of these findings Bozhenko maintained that the species other than the water-rats played but a secondary role as sources of tularemia infection. He admitted, however, that these animals could be of importance in some limited regions of the delta area if a water-rat epizootic was present or if their numbers had become extraordinarily increased. At the same time Bozhenko noted that such an unusual population increase could take under ecological conditions of the delta area only in separate and not in extended sectors.

The importance of the water-rats, on the other hand, could hardly be overrated. These animals were extremely numerous, up to 5 million of their skins having been collected from 1945 to 1954. They were found to be tularemia-infected not merely every year but during each season of every year. Under these circumstances it was not surprising that during each of the last twenty-five years the disease became manifest in the human population of the Don Delta in epidemic or at least in sporadic form. The most recent detailed data available, according to whom a total of 140 tularemia cases was recorded there in 1955, 15 of these attacks (causally related to the hunting of water-rats) taking place in February-March, while a vector-borne epidemic involving 125 persons was observed during the period from July to October.

- (d) Stalingrad Oblast. - Adequate references to comparatively recent tularemia manifestations in the "ravine-steppe" foci of the Stalingrad Oblast can be found in a series of publications by Borodin and his associates (1956, 1957,

## Tularemia-60

1958, 1959). In the opinion of these workers (1959) not only Apodemus falvicollis (as they had originally believed) but also several other small mammalian species could serve as tularemia reservoirs in the foci in question, but a most important role in the carry-over as well as in the transmission of the infection was played by the ticks Dermacentor marginatus and Rhipicephalus rossicus. Borodin and his colleagues stated in this connection that during the period from 1954 to 1957 they had isolated 141 tularemia cultures--one from M. musculus, two from A. falvicollis, 103 from D. marginatus, 34 from Rh. rossicus and one from tick Ixodes laguri.

It would seem that human tularemia infections had been absent from the study area since 1954, when Borodin and his co-workers (1956) had observed two attacks of the disease caused by bites of Rh. rossicus. As stated in an additional article (1958) in the following year they noted local allergic reactions in two persons who had been vaccinated against tularemia in the past and had been bitten recently by Rh. rossicus. Ticks collected from these two individuals proved to be tularemia-infected.

Reporting in 1958 on the results of extensive investigations made in the northern part of the Volga-Akhtuba floodlands (see particularly the contributions by Borodin, 1958 a, b; IAmolova et al., 1958; Kucheruk et al. 1958 a, b and Olsuf'ev et al. 1955 b, 1958 a, b, c), Olsuf'ev and his associates summarized that

"(a) the causative organism of tularemia were repeatedly observed during the period from 1951 to 1954 in the ticks D. marginatus and Rh. rossicus, mosaically distributed in the Volga-Akhtuba floodlands. Altogether from 1952 to 1954 a bacteriological examination of 47,000 sexually mature ticks yielded 37 tularemia cultures.

(b) Bacteriological examinations made during 4 years on 13,000 water-rats, collected mainly during the periods of inundation in sites of their maximal concentration gave a negative result. It thus appeared that the fundamental colonies of the rats in the floodlands were during these years free from tularemia.

(c) The localities where infected ticks were observed, are considered by us as permanently active or elementary foci, from which under suitable conditions the infection is spread in the form of diffuse epizootics among the water-rat populations of a considerable part of the floodlands - as has been observed in the past.

(d) The elementary tularemia foci are characterized by the presence of many vectors and hosts. The preservation and circulation of the infection in them is insured by the ixodes tick species D. marginatus and Rh. rossicus and a number of species of rodents highly susceptible and sensitive to tularemia: the water-rat, common vole, partly the common hamster and the house-mouse....

(e) The tularemia infection rate of the ticks varied in different years, conditioning different levels of the spread of the disease among the rodents: a sporadic morbidity in some years, localized epizootics in others. These oscillations were related to variations of the numbers of rodents in the elementary foci.

(f) All tularemia strains isolated from the ticks were typical in their biological properties and highly virulent...."

Referring to the incidence of tularemia in man, Olsuf'ev and his associates declared that, though the elementary foci of the infection continued to exist, it had been possible altogether to prevent the appearance of the disease in the human population of the floodlands during the period from 1951 to 1957. They added that the absence of tularemia among the water-rat hunters demonstrated particularly well the efficacy of anti-tularemia vaccination used on a large scale. This was all the more noteworthy because as stated by Borodin (1958 b), the hunting of the water-rats had been undertaken on an intensified scale as one of the means to fight tularemia in the floodlands.

## Tularemia-62

- (e) Volga Delta. - Summarizing the important ecological observations made by Kondrashkin (1955)<sup>1</sup> in a report not accessible to the reviewer, Maksimov (1960) stated that in the Volga Delta, the most seriously affected flood-land area in the European part of the Soviet Union,

"all tularemia outbreaks were invariably connected in one or another way with epizootics among the most numerous water-rats. It is interesting that in the delta, side by side with vector-borne outbreaks and such in relation to the hunting of water-rats, there occurred also sometimes instances of infection due to the threshing of grain. Still, in contrast to other foci, whatever the mode of infection might be, its source was always the water-rats, vectors becoming infected from them and also contaminated environmental objects. As Kondrashkin states, thus far human infections due to other rodents have never been observed in the delta.... The overwhelming number of tularemia cultures was isolated from the water-rats and only an inconsiderable amount from other species. It is important to note, that almost always at the time of the epizootics the tularemia cultures were obtained from the water-rats.... Even in the years during which the small mouse-like rodents become numerous (usually in autumn), no epizootics developed among them. As the author points out, this indicates that in this area the small mouse-like rodents do not have an independent epizootological and epidemiological importance."

With regard to the incidence of tularemia in man one should underline the fact that, although it has not been possible to give chapter and verse for each year in

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1. Besides the contribution of Kondrashkin, noteworthy recent publications dealing with the tularemia problem in the Volga Delta have been made by Dereviachenko and Zheldakova (1958); Gureva et al. (1958); Guseva and Fitonova (1962); Novikova (1951, 1952); Pilipenko (1949, 1953 a, b); Pilipenko and Dereviachenko (1955).

### Tularemia-63

the preceding parts of this review, according to the statements of several authors (e. g. Pilipenko, 1949, 1953 b); Kondrashkin, 1955 and Bozhenko, 1957) human manifestations of the disease have appeared perennially in the Volga Delta in the past.

Valuable data on the recent occurrence of tularemia outbreaks in the Volga Delta in general and in the city of Astrakhan in particular have been furnished in the 1962 article by Guseva and Fitonova.

As stated by the two observers, in the past the practically perennial tularemia outbreaks in the deltaic foci had frequently led to manifestations of the disease among the population of the city of Astrakhan which is situated about 40-50 km north of the affected raions. Usually the town population became involved during the years in which the incidence of the disease was high in the latter. Noteworthy, too, was the fact that the infection often appeared in persons who had not left the city.

Tularemia was absent from the area during the period from 1952 to 1956. It was evidently for this reason that, in contrast to the affected delta raions, where since 1946 mass anti-tularemic vaccinations have been administered year by year, only a limited number of the town residents (23,138 during five years) were immunized.

In the spring of 1957, as a result of (a) a high population density of the water-rats; (b) an abundance of blood-sucking diptera and (c) high inundations a tularemia epizootic became manifest in the lowlands of the Volga Delta. This continued for the following two years. Throughout this period positive cultures were obtained from the water-rats, and in 1958 also from field and house mice.

As a result of this epizootic the human population of 6 deltaic raions became affected with tularemia in the spring and summer of 1957 and 1958 and sporadic attacks continued to appear in 1959. The incidence of the disease in the oblast as a whole, and especially in Astrakhan city is shown in the following tabulation:

Tularemia-64

	<u>1957</u>	<u>1958</u>	<u>1959</u>
Whole Oblast	228	204	10
Astrakhan City	47	126	6

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Details of the two major outbreaks in the city were as follows:

In 1957 sixteen persons fell ill from 20 May to 8 June. All had visited the foci to hunt water-rats and all had axillary buboes.

From 17 August to 26 September 31 persons fell ill with attacks of ulcero-bubonic tularemia, all as a result of vector-borne infections. Only 11 had visited the foci.

In 1958, during the period from the end of April to the middle of June, 4 tularemia attacks related to the hunting of water-rats in the foci were noted. Out of the 122 persons contracting vector-borne infections from the middle of June to the beginning of October

Had not left town	9
Lived in suburban villages	31
Had visited the environs of the city	14
Had visited or approached the foci	68

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122.

An outstanding fact here is that out of the 179 persons who fell ill in Astrakhan from 1957 to 1959 only four had been immunized against tularemia.

Guseva and Fitonova, taking into account that (a) water-rats occurred but scantily in the environs of Astrakhan and had never shown evidence of tularemia infection and (b) the overwhelming majority of the vector-borne affections in the city and its vicinity was observed at the time of a prevalence of winds blowing in the

direction from the epizootic foci towards Astrakhan, came to the conclusion that the winds "may have played a role in the transfer of infected mosquitoes from the natural focus into the town and its vicinity." However, the two authors mentioned also that, as postulated by Novikova (1952), small river boats might have transported infected mosquitoes into the city.

- (f) Caucasus and Transcaucasus. - Comprehensively discussing the problems of tularemia and its control in the Caucasus and Transcaucasus, Pilipenko (1961) stated that in these parts active foci of the infection existed in the Stavropol' Krai, the Chechen - Ingush, Kabardino-Balkarian, North Ossetian and Dagestan Autonomous Republics as well as in the Union republics of Azerbaidzhan, Georgia and Armenia.

In most of the foci situated in the Stavropol' Krai, voles (Microtus arvalis) were the main reservoir of the infection, but in some districts tularemia was entrenched among the water-rats. In the former foci the disease has been known to exist from 1938 up to the present. While the infection was formerly rampant among the voles, within the last 4-6 years the epizootics showed signs of a regression, due mainly to a decreased incidence of the rodents, which in its turn was brought about by the mechanization and acceleration of the harvesting operations. The decreased population density of the voles also led to a decreased incidence of the tick vectors; moreover during the period from 1950 to 1959 almost 50 million of cattle, sheep and horses had been freed from ticks.

Owing to these favorable circumstances, tularemia manifestations in man, which in the past had been rampant at times in the Stavropol' Krai, became rare, only 3 attacks respectively being recorded in 1956 and 1959. In addition to the lessened activity of the natural focus, this greatly decreased incidence of the disease was due also to the large-scale administration of anti-tularemia vaccinations, the number of inoculations administered during the period from 1945 to 1959 amounting to over 1 million (corresponding to over 77% of the rural population).

Recently active foci of tularemia in the Stavropol' Krai related etiologically to water-rats have been found to be situated (a) in the Karachay-Cherkess Oblast and (b) along the lower course of the Kuma River. In the



### Tularemia-66

first mentioned region a water-rat epizootic was detected in 1946 and the presence of the infection was again confirmed in 1959 by the isolation of a tularemia culture from nymphs of the tick Dermacentor marginatus. On the Kuma River 11 attacks of tularemia (ulcero-bubonic type) were noted in the autumn of 1958 and at the same time positive cultures were obtained from water-rats, gamasidae collected from these rodents and also from Gerbillus meridianus.

In the Dagestan ASSR two tularemia foci were found to exist. The first of these, situated in the north of the republic in the floodlands of the Terek and Tavlovka rivers and known to exist since 1941, was causally related to epizootics among the abundant water-rats, from which tularemia cultures were isolated every year from 1957 to 1959. A major vector-borne tularemia epidemic (579 cases), taking place in this area in 1955 and involving mainly the Kizliar, Tarumovskii and Krainovskii raions, has been described in detail by Pilipenko (1959) who postulated that a transport of infected mosquitoes by the prevailing winds played an important role in the spread of the disease. Further epidemic manifestations of tularemia were prevented through wholesale immunization of the population. The sporadic attacks recorded after 1955 (2 cases in 1956; 23 cases in 1957; 7 cases in 1958 and 4 cases in 1959) occurred mainly in persons who had not received anti-tularemia vaccinations.

A second focus of the "mouse" type was detected in the winter of 1955-1956 in the southern coastal part of the republic, when a tularemia epidemic involved five raions. Numerous cultures of B. tularense were isolated at that time from various species of small rodents including Microtus socialis, M. arvalis, Mus musculus and Apodemus silvaticus. Instances of infection among the first mentioned animal (M. socialis) were still observed in the spring of 1957 near the railway station of Manas. Large-scale anti-tularemia vaccination of the population, instituted after the 1955-1956 epidemic, was evidently responsible for the absence of further manifestations of the disease in man.

In the Chechen - Ingush ASSR tularemia attacks in man had been recorded since 1942, followed in 1943 and again in 1955 by the detection of the infection in the mouse species (Malgobekskii Raion). In 1959 the presence of tularemia among the rodents and pasture ticks was demonstrated in the Sunzhenskii Raion. Attacks

## Tularemia-67

in man were notified there in 1956 (2 cases), 1957 (4 cases) and 1959 (4 cases). In the winter of 1959-1960 a tularemia epizootic evolved among the mouse species which had become particularly numerous at that time, and the presence of the infection was also confirmed in March, 1960 among various ticks, particularly D. marginatus. However, large-scale vaccination campaigns and also rodent eradication in an extended area (almost 70,000 hectares) prevented the appearance of the disease in man.

The presence of tularemia among the rodent and human populations of the North-Ossetian Autonomous Republic was established in 1953 but evidently further manifestations of the disease in man were prevented through vaccination campaigns.

In the Kabardino-Balkarian ASSR tularemia manifestations in man, causally related to epizootics among the mice and allied species were recorded periodically from 1941 to 1953. A further appearance of the disease in the human population was evidently prevented through large-scale anti-tularemia vaccinations, administered during the period from 1955 to 1959 to 44.9% of the rural population and also through rodent eradication, undertaken in 1958-1959 in a territory of 33,628 hectares.

Turning his attention to the tularemia-affected areas in Transcaucasia, Pilipenko stated that the infection appeared to have become manifest in Georgia in 1946. The presence of the disease was afterwards confirmed there among M. arvalis and pasture ticks in the environs of Tbilisi, while in 1959 an epizootic among voles, Meriones erythraurus and other rodents was observed in four raions of eastern Georgia.

Though the infection appears thus to be entrenched in a comparatively large part of Georgia, during the period from 1956 to 1959 human manifestations of tularemia have been slight, 20 cases having been recorded in 1956 and 4 attacks in 1957. Anti-tularemia vaccinations were administered at that time to 7.5% of the rural population, mainly in the affected raions.

It seems well to quote, before dealing with Pilipenko's description of the recent tularemia situation in Armenia, the following summary of Maksimov (1960):

## Tularemia-68

"Tularemia epizootics were observed in this republic in 1952, 1953 and 1954 among water-rats, common voles, forest mice, Minor-Asiatic susliks (sisels). Meriones persicus and other rodent species, the water-rats forming the fundamental reservoir of the infection (O. V. Ovasapian, 1956). The focus became epidemiologically manifest through the appearance of the disease among workers in meat-packing factories<sup>1</sup> and on sheep-breeding farms in connection with epizootics among the sheep. Water-borne infections also took place.

It is possible that the Armenian foci belong to the category of the valley-brook sub-type of the swamp-lake-river ("arvicolar") type of foci, what is confirmed through the statements made O. V. Ovasapian (1957) in regard to the Gukasianskii Raion...in which an epizootic took place in 1954.... This epizootic involved more than 28 settlements where 11 tularemia strains were isolated from water-rats concentrated on the shores of the rivers and springs. Cultures were also obtained from the common voles (6 strains) and, one strain each, from Brandt's hamsters, forest and house mice, etc.

The similar focus in the Aginskii Raion is classified by V. N. Zil'fian (1957) as belonging to the floodland-river variant of foci.... Besides in water-rats, caught on the shores of the river Akhurian, a tularemia epizootic was recorded among the common voles, forest mice, river crabs, etc. The attacks in man were of the anginose-bubonic form....

Because of the findings made in the Noemberinskii Raion of Armenia, the same author describes a forest type of focus where the fundamental reservoir of tularemia are the ixodes ticks and the fundamental source of the infection--forest mice and black rats....

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1. See the paper by Smirnov (1956). Other noteworthy recent publications on tularemia in Armenia not quoted above are those of Olsuf'ev et al. (1953) and Mnatskanian et al. (1961).

The tularemia focus in a mountainous raion described by Drobinskii and Klimukhin (1948) has not yet been investigated. The human attacks there were related to the consumption of the (insufficiently cooked) meat of antelopes, mountain goats, bears and possibly wild pigs."

According to Pilipenko, tularemia, first detected in Armenia in 1949, had affected up to 1959 seven raions in the northeast of the republic. A distinction could be made between (a) foci etiologically related to the water-rats (Agiinskii, Gukasianskii, Akhtinskii raions and others) and (b) foci where the reservoirs of the infection were forest mice, common voles and black rats (Zil'fian, 1958). While the natural foci remained active, a considerable number of tularemia cultures having been isolated from rodents and ticks in 1959, recently human manifestations of the disease were recorded only in the Agiinskii Raion (one case in 1956) and the Alaverdskii Raion (53 cases). As maintained by Pilipenko

"This comparatively inconsiderable morbidity appears to find its explanation in the peculiarities of the foci of the infection in Armenia and in connection with this in a 'low epidemicity' of the foci in comparison with those of the floodland-marsh type, where vector-borne infections and massive contact infections at the time of water-rat hunting predominate, or with the foci in the agricultural zone of the Soviet Union where the mouse-like species are a massive source of infection. At the same time, however, no doubt vaccine-prophylaxis and other anti-tularemia measures (campaigns against the rodents and ticks), actively implemented in the affected raions of Armenia, played a role in the prevention of the disease. From 1956 to 1959 400,327 persons were vaccinated or revaccinated against tularemia, i. e. 27.6% of the population of the republic or 45% of the rural population."

As quoted by Pilipenko, Abushev and his associates (1959) established in 1958 the presence of tularemia in water-rats, common voles, forest mice and other rodents

## Tularemia-70

in the mountainous Shabuzkii Raion of the Azerbaidzhan SSR. To judge from incomplete information, the first mentioned species (water-rats) formed the reservoir of the infection. Still less is known about the Pushkinskii Raion, where common voles and pasture ticks were found affected. Both these foci were still found to be active in 1959.

That tularemia affected also the human population of Azerbaidzhan could be proved with the aid of tularin tests, found to be positive in 6 out of 78 persons examined in the Shabuzkii Raion.

The number of anti-tularemia vaccinations administered from 1957 to 1959 in the tularemia-threatened raions of the republic amounted to 148,091, i. e. 4% of the total and 7% of the rural population.

- (g) Orenburg Oblast. - Attention has been drawn already in the preceding section of this review (see p. 43) to the repeated reappearance of tularemia in the Orenburg Oblast during the period presently under review--according to the 1961 report by Volkova and Iushkin up to 1959.
- (h) Bashkir ASSR. - To judge from the title of a paper by Vasil'eva and her co-workers (1959), which was not available in the original, sporadic attacks of tularemia have been recently recorded in the Bashkir ASSR.

## Ural Regions

It is justified to deal in this review comprehensively with the tularemia-affected areas in and near the Ural mountains because, though partly situated in the European part of the Soviet Union (Kirov and Perm oblasts, Udmurt ASSR) and partly located in Siberia (Cheliabinsk, Kurgan and Sverdlovsk oblasts), they form one entity as far as tularemia is concerned.

As can be gathered from the publication of Ogarkov and his associates (1960), to which attention has been paid already in the preceding section of the present review, the period of a highly increased incidence of tularemia in these parts in 1948-1949 was mostly followed by a lull lasting until 1957. An exception was formed by the Kurgan Oblast, where the tularemia morbidity rate per 10,000 population was 0.68 in 1951, 0.41 in 1954 and rose to 1.6 in 1955 (epidemic in the Petukhovskii Raion).

## Tularemia-71

According to Ogarkov and his colleagues, the factors responsible for the recrudescence of tularemia in the regions presently under review in 1957 were (a) a great increase of the water-rat populations and (b) high spring floods in the rivers followed by a hot and dry period in May and June proving destructive to the vegetation except along the waterways and lakes and leading therefore to a concentration of the mouse and vole species in the latter sites and thus to a close contact of these rodents with the water-rats. It was not surprising, therefore, that besides the latter many other rodent species became involved in the wide-spread epizootic evolving in 1957. Besides in the water-rats, the presence of tularemia was proved in field mice in the Kirov Oblast, in forest and house mice in the Cheliabinsk Oblast, in a musk-rat in the Kurgan Oblast, in Clethrionomys rutilus in the Sverdlovsk Oblast. Indirect proofs for the presence of an epizootic were furnished by the appearance of tularemia in water-rat hunters in the Kirov Oblast and in persons in contact with hares (Lepus timidus) in the Sverdlovsk Oblast as well as by the observation of a considerable mortality of the musk-rats in the Kurgan Oblast.

The incidence of human tularemia in 1957 was

<u>Oblast</u>	<u>Case Incidence</u> <u>per 10,000</u>	<u>Oblast</u>	<u>Case Incidence</u> <u>per 10,000</u>
Kirov	4.21	Udmurt ASSR	0.12
Sverdlovsk	2.76	Cheliabinsk	0.03
Perm	0.26	Kurgan	0.02

In respect to the low incidence of the disease in the Kurgan Oblast it is important to note that there during the period from 1952 to 1957 not less than 64.7% of the total population or 79.8% of the rural population had been vaccinated against tularemia.

As in the past, the 1957 tularemia outbreaks in the above mentioned regions were mainly vector-borne and consequently over 90% of the patients were found to suffer from the ulcero-bubonic form of the disease.

In a quite recently published article, Kon'shina (1962) reported upon the preliminary results of investigations

## Tularemia-72

in the regions of the Sverdlovsk Oblast where hitherto no evidence for the occurrence of tularemia had been elicited. She maintained that the necessity for such studies

"was dictated by the results of an epidemiological analysis of the tularemia outbreaks among the population of the oblast which showed that every time these outbreaks took place in new raions. Up to 1958 out of 55 raions 22 proved to be endemic while in the others human tularemia had never been recorded. It was possible to postulate that in a number of the raions of the oblast in a number of the raions of the oblast there existed the source of the infection - rodents, but conditions favorable for the evolution of large epizootics with epidemic sequelae had not yet been created and the foci were in a latent state. It was also possible that epizootics among the rodents remained unnoticed and attacks of tularemia in man were not diagnosed."

In order to detect past human infections, 977 tularin tests were made. 320 of these, with which the present report deals, were made in 1958 in the Sysertskii Raion and gave a positive result in 7 instances. Consequently in 1958-1959 bacteriological examinations of 219 rodents and 30 insectivora were made which led to the isolation of tularemia cultures from 3 animals (a Clethrionomys glareolus, a Cl. rutilus and an Ondatra zibethica). Further in August 1958 three tularemia attacks were observed in persons who, visiting the Sysertskii Raion, had lived in tents in the forest for three days.

The significance of these findings and the need for prophylactic work were emphasized by the author.

## West Siberia

In addition to the data for the early fifties of the present century furnished already in the preceding section of this review (see p. 44, supra) and those for the oblasts east of the Ural recorded above, the following information is available in regard to the recent incidence of tularemia in West Siberia:

## Tularemia-73

Tiumen Oblast. - Maksimov (1960), besides drawing attention to a great numerical increase of the water-rat populations in the Tiumen Oblast (as well as in the Kurgan and Omsk oblasts) during the period from 1947 to 1950 (see also Ageenko, 1954) and a new rise in the frequency of these rodents in the Kondinskii Raion in 1953, also stated that in 1951 three tularemia attacks had been observed at Tobolsk in persons occupied with the harvesting of hay. A vector-borne infection was likely in at least one of these patients.

Omsk Oblast. - To judge from an article by Dalmatov (1962), an apparently considerable tularemia epidemic, causally related to a water-rat epizootic, was observed in the summer and autumn of 1961 in the city of Omsk.

Novosibirsk Oblast. - Dealing with the Novosibirsk Oblast, Maksimov (1960) stated that (a) in connection with a greatly increased frequency of the water-rats in the Karasukskii Raion during the period from 1951-1954, human tularemia outbreaks were observed there in 1951 and possibly also in the following years; (b) the incidence of tularemia was high in the Kulundinskii (steppe) raions in 1952 and 1953 (53.5%, respectively 41.5% of the total cases noted in the oblast); and (c) an increased incidence of the disease was observed in the Novosibirsk Oblast in 1955. It is noteworthy that, even though then the water-rats were not numerous in general, the prevailing dryness led to a concentration of the animals in sites with an adequate moisture which were also frequented by the human population.

Kemerovo Oblast. - In an article already referred to in the preceding part of this review (see p. 45 supra), Kuzina (1959) recorded the following tularemia incidence in the Kemerovo Oblast from 1952 onwards (when, according to her the disease ceased to be epidemic):

<u>Year</u>	<u>Case Incidence</u>	<u>Year</u>	<u>Case Incidence</u>
1952	67	1955	30
1953	62	1956	9
1954	37		

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#### Tularemia-74

Thus in 1956, when only 3 raions were found to be affected, the tularemia incidence per 10,000 population was only 0.035 as against 2.7 in 1949.

It would appear that during the period from 1957 to 1959 sporadic tularemia attacks were noted in 5 raions where, in contrast of the other parts of the oblast, no thorough prophylactic work was done.

While all water-rats examined from 1951-1956 proved negative,<sup>1</sup> tularemia cultures were repeatedly isolated from specimens of water collected outside the settlements. It is under these circumstances not surprising that 98% of the above recorded attacks were due to a water-borne infection contracted in the course of agricultural work. In accordance with this mode of infection, the anginose-bubonic form of the disease was prevalent (84.1%). The outbreaks occurred in summer (June-August) with an acme in July.

Tomsk Oblast. - In their 1961 article, Karpov and Tiazhkun furnished the following figures on the incidence of tularemia in the Tomsk Oblast:

<u>Year</u>	<u>Case Incidence</u>	<u>Year</u>	<u>Case Incidence</u>
1950	271	1955	5
1951	33	1956	1
1952	84	1957	2
1953	14	1958	0
1954	2	1959	1
		<u>Total</u>	<u>413</u>

Remark. - Of these attacks, 67.1% were the result of contact with water-rats, 16.7% were due to vector-borne infections and only 5% water-borne.

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1. However, water-rats, the fundamental reservoir of the infection, had been repeatedly found tularemia-affected in the past.

The two authors justly ascribed the great decline in the incidence of the disease since 1953 to the mass vaccination campaigns conducted in the oblast from 1950 onwards. It is interesting to note in this connection that, as shown by the authors in a graph, the frequency of the water-rats, evidenced by the number of skins obtained from these animals, was high during the period from 1951-1953. The epizootic then evolving, which reached its maximum in 1953, led to a decimation of the herds. To judge from the number of skins obtained, the size of the water-rat herds again increased quite considerably in 1958 but, no doubt due to the high level of immunity produced by then in the human population, there was no parallel increase of the incidence of tularemia in man.

#### Altai Krai

The recent tularemia situation in the Altai Krai has been the subject not only of investigations by workers like Kokliagina (1955) and Kir'ianov (1957) but also of profound studies by Olsuf'ev and his associates (1957, 1959).

Kokliagina, studying the insect fauna in the Altai Krai, drew attention to the occasional causation of tularemia attacks in man by tick-bites. Kir'ianov in a paper quoted earlier in this review (see p. 40 supra), stated that the water-rat epizootics in that area, while continuing on the level reached in 1950 during the next following years, showed a marked decline during the period from 1953 to 1956, due to a decrease in the frequency of these rodents.

In the final report on the studies conducted by them in the Altai Krai from 1955 to 1957, Olsuf'ev and his co-workers (1959) referred to the occurrence of water-rat epizootics in the Kytmanovskii Raion in 1955 and in the Starobardinskii Raion, the area of their investigations, in 1956. As noted earlier in this review (see p. 45 supra), these authors noted a yearly occurrence of human tularemia attacks there from 1948 onwards. They added, however, that owing to the administration of specific vaccinations and the prevention of the use of contaminated sources of water-supply the disease became absent in man during the period of their studies.

Since the majority of the patients found in the past had fallen ill in summer at the time of the hay-harvest and showed signs of an anginose-bubonic affection, there was

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little doubt that an infection through the consumption of tularemia-contaminated water played the main role in the genesis of the disease in the Altai Krai. However, infections due to the bite of ticks were also on record.

Comparing the records of human tularemia manifestations with the results of tularin tests, Olsuf'ev and his associates established the interesting fact that the number of persons showing an allergic reaction was 12 times higher than that of the officially reported patients.

The laboratory investigations made by these workers led to the isolation of 60 tularemia strains--8 from water-rats, 5 from ticks, two from fresh-water shrimps and 45 from water samples.

The important conclusions reached through this study were that

"1. The natural tularemia foci of the foothill brook type in the Altai Krai are maintained fundamentally by water-rats and ixodes ticks (Dermacentor silvarum, Haemaphysalis concinna and, probably, other species).

2. The tularemia contamination of the brooks observed in the foci of the above mentioned type in summer stands in connection with water-rat epizootics.

3. The water-rats not only infect the water with tularemia bacilli but are apt to become themselves infected by it.

4. After the termination of the water-rat epizootics the brook water may remain infected for a considerable time. This phenomenon can be satisfactorily explained only by the assumption that the tularemia bacilli subsist in the ooze and the accumulations on the shore of the brooks.

5. A role of the aquatic animals in the maintenance of the water-infection in the brooks could not be confirmed. The shrimps (Gammarus) found tularemia-affected in infected brook water were merely mechanical carriers of the infection.

6. The tularemia strains isolated from water were as highly virulent as those from water-rats and ixodes ticks and practically not different from the strains described in the European part of the Soviet Union.

7. Besides tularemia bacilli one may observe in the brook water the causative organisms of erysipeloid and listeriosis; the water-rats are likewise the reservoirs of the latter infections.

8. Human tularemia infections due to the consumption of contaminated brook water were observed fairly frequently in the past in the above described focus; in persons immune to tularemia (convalescents or vaccinated) the consumption of such water may produce an allergic reaction accompanied by a short-term loss of the working capacity.

9. The basic prophylaxis of tularemia in the foci of the foothill brook type consists of a carefully conducted inoculation of the population with specific vaccine and a sanitary survey of the water supply system. An improvement of the sanitary conditions of the foci can be achieved through a regulation of the frequency of the water-rats (hunting, eradivative measures) and campaigns against the ticks."

Though the recent tularemia situation in the Kazakh Republic has been dealt with in a considerable number of publications,<sup>1</sup> according to Maksimov (1960) the ecology of the infection in this enormous area including vastly different kinds of landscapes is not yet fully known. For in addition to valley-brook foci in the foothills and mountains, inter-fluvial lake foci and not numerous river-floodland foci others existed which did not correspond to any of the hitherto described types.

Discussing the manner in which the water-rats were related to these foci, Maksimov stated that

"Tularemia was long known to exist in the south-eastern part of the Kazakhstan in the plains as well as in the foothills. In the Alakulskii Basin (Sasykul' and Alakul lakes) outbreaks of this infection

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1. See the articles by Aikimbaev (1958, 1959 a, b); Bozhenko (1950); Ershova (1961); Ershova and Afans'eva (1959); IAshkul (1959); Kamennova and Smirin (1959); Karakulov et al. (1957); Kim (1958); Kraft (1962); Kucherov et al. (1958); Makirov and Karakulov (1961); Osokina and Romashova (1959); Shmuter (1957); Shmuter and Svizent (1958) and Strautmann (1957).

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are frequent. The fundamental participants in the epizootics--the water-rats--live in some years in enormous numbers on the shores of these lakes and also on numerous springs and brooks....

In the foothills of the Dzhungarskii and Zailiskii Alatau tularemia is also related mainly to the water-rats living there on brooks and small rivers.... Besides the water-rats, Microtus gregalis, M. arvalis, forest, field and house mice are involved in the epizootics....

In the deserts tularemia continues among the numerous local rodent species: big, tamarisk and midday gerbils, small, yellow and median susliks (sisels) and house mice which sometimes abound in the river floodlands and near wells. It is most interesting that when an intense epizootic (involving gerbils, mice and Lepus tolai) took place in the Ili River Delta, the water-rats and musk-rats living on adjacent waterways remained unharmed. In the Ili Delta tularemia epizootics among the rodents were observed several times, but the musk-rats did not become involved (slight contact)....<sup>1</sup>

Further studies are required in regard to the classification of the tularemia foci in the West-Kazakhstan Oblast (see Tumanskii and Kolesnikova, 1935)."

As quoted by Maksimov, Bozhenko (1950) maintained that in the "mountain-valley" foci of the Kazakhstan other animal species, even including toads, fish and mollusks, took part in the maintenance of the tularemia infection

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1. The following, however, deserve attention: (a) according to Strautman (1957) in the northern and central part of the Kazakhstan, where the musk-rats often lived in contact with the water-rats, they did sometimes become involved in the epizootics originating among the latter rodents; and (b) Kamennova and Smirin (1959) observed in the winter of 1957-1958 a mass mortality of the musk-rats in the Syr-Dar'ia Delta leading to the appearance of tularemia among the hunters of these animals. Several other rodent species were involved in the epizootic but the musk-rats seemed mainly responsible for the conveyance of the infection to man.

and that a most important role was played in this respect by the tick Dermacentor marginatus. Besides this species also Haemophysalis ticks were found spontaneously tularemia-infected in the Kazakhstan.

Except in the case of the Akmolinsk Oblast, dealt with below, the information available in regard to recent tularemia manifestations in individual parts of the Kazakhstan is regrettably scanty.

Maksimov (1960) observed an outbreak in the floodlands of the Irtysh in the Pavlodar Oblast in 1954. This outbreak was causally related to a water-rat epizootic. An early phase, during which tularemia attacks occurred among the hunters of these animals, was followed by a vector-borne outbreak lasting from the middle of June to the end of August, the incidence of the disease being maximal in the second half of July (41.9% of the attacks).

Kuchеров and his associates (1958), in one of the few articles on recent tularemia outbreaks in the Kazakhstan available to the present reviewer in the original, described a tularemia epizootic in the winter of 1955-1956, involving an area of almost 4 million hectares in 4 raions of the West-Kazakhstan Oblast in which mainly steppe lemmings and common voles, but also other species including small susliks, gerbils and Sorex were found to be involved. In spite of the seriousness of the situation, energetic prophylactic action, including wholesale anti-tularemia vaccination in and around the affected raions, prevented a transition of the infection to man.

As quoted by Maksimov, Kim, in an article published in 1958, described a tularemia outbreak in the Udzharskii Raion of the Semipalatinsk Oblast. Infection was no doubt mainly water-borne, because 94% of the 66 patients seen suffered from the anginose-bubonic form of the disease.

In an excellent article on the epidemiology of tularemia in the Akmolinsk Oblast (quoted earlier in this review), Kraft (1962) furnished the following data on the incidence of the disease during the period from 1946 to 1958:

(see table on page 80)

Dealing with the ecology of the disease in the region under review, Kraft maintained that all outbreaks and sporadic attacks were directly or indirectly causally related to the water-rats and that the numerous foci found were invariably located in sites inhabited by these animals.

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<u>Year</u>	<u>Case Incidence</u>	<u>Year</u>	<u>Case Incidence</u>
1946	222	1953	-
1947	59	1954	93
1948	-	1955	7
1949	30	1956	4
1950	-	1957	3
1951	4	1958	261
1952	-		
			Total 683

The 683 human attacks recorded above could be classified as follows:

<u>No. of Cases</u>	<u>Category</u>
537	Vector-(Aedes)-borne infections contracted from August to October during the hay-harvests and occurring in epidemic form in 1946, 1949, 1954 and 1958. Type of the disease: Ulcero-bubonic.
48	Outbreaks observed in 1949 and 1954 and causally related to the hunting of water-rats or handling of their skins. Type of the disease: Ulcero-bubonic (ulcers on the hands, cubital or axillary buboes).
10	Bubonic attacks observed in spring 1954 (7 cases) and in autumn 1958 (3 cases) also related to the hunting of water-rats.
12	Attacks of ulcero-bubonic tularemia, due to the bite of ticks, apparently of <u>Dermacentor marginatus</u> .

### Tularemia-81

<u>No. of Cases</u>	<u>Category</u>
59	Attacks of the anginose-bubonic form of the disease, observed with one exception in January/February 1947 and due to the consumption of contaminated water.
3	Attacks of the pulmonary form of tularemia, observed in May 1954 in persons engaged in the sorting of water-rat skins.
2	Patients with the ocular form of the disease, observed in 1957, respectively in 1958. One of the sufferers was known to have washed with the water of a lake round which a tularemia epizootic was present.
12	5 of these patients, the history of which was unknown, were apparently water-rat hunters.

### Turkmenia

Discussing the tularemia situation in Turkmenia, Maksimov (1960), besides drawing attention to the 1945-1947 outbreak dealt with earlier in this review (see p. 38 supra), stated that Gonchareva and Kutuev (1958) had also more recently found evidence of tularemia infection among the house mice of Tashauz. Presumably, therefore, this focus still remains active.

### Eastern Siberia

Krasnoiarsk Krai. - Though, as stated by Antsiferov and his associates (1957 b), the presence of tularemia in the Krasnoiarsk Krai was officially recorded in 1950 only, retrospectively made tularin tests indicated an earlier occurrence of the disease in persons affected in the Biriliusskii Raion in 1927 and 1948 respectively, among inhabitants of the Pirovskii Raion in 1944, 1947 and 1948.



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As described by Antsiferov and his associates, a major tularemia outbreak took place in 1950 in the Biriliusskii Raion when from July to September 202 attacks were recorded in 24 settlements situated on the Chulina River. Though no evidence of an epizootic could be obtained, it was certain that the infection was primarily present among the water-rats. However, the human outbreak, in which 70.7% of the patients suffered from the ulcerobubonic form of tularemia and 10% from the bubonic form, was mainly vector-borne. Actually it was possible to prove the presence of tularemia in Aedes vexans, the prevalent mosquito species in the raion.

As also recorded by Antsiferov and his colleagues (1958, 1959), a tularemia outbreak causally related to the hunting of water-rats took place in 1953 in the Turukhanskii Raion situated far north in the Krasnoïarsk Krai on the Enisei River.

Irkutsk Oblast. - As maintained by Altareva and her co-workers in a 1957 report, the apparent rarity of tularemia in the Irkutsk Oblast, where muskrats as well as water-rats abounded, was merely the result of insufficient information. Be this as it may, with the exception of an outbreak recorded by Klets in 1957 (see p. 20 supra), definite information on the presence of tularemia in the Irkutsk Oblast was lacking until 1951, when a tularemia attack was observed in a cowherd living in the open in the Nizhne-Ilinskii Raion who shortly before falling ill had skinned an evidently infected muskrat.

This event stimulated a survey made in 1953 in the Bratskii Raion which was chosen for this purpose because (a) it was adjacent to the formerly affected Nizhne-Udinskii and Nizhne-Ilinskii raions and (b) in addition to water-rats it was heavily populated by muskrats which, having been introduced into the raion in 1937, had multiplied so rapidly that they were amply hunted from 1940 onwards.

In the course of 1953 tularin tests were made on 1,288 persons in 16 settlements of the Bratskii Raion. Positive results were obtained in 13 persons, but only 5 of these (3 adults and 2 adolescents) yielded a history suggestive of a previous tularemia attack. However, the presence of the infection in the raion could also be confirmed through the

the isolation of tularemia cultures from a water-rat and a Dermacentor silvarum tick. In view of these findings the authors stressed the necessity of preventive measures and of a control of the musk-rat hunting in the Bratskii Raion where a large hydro-electric station was in the course of construction.

Buriat(-Mongol)-ASSR<sup>1</sup>

Continuing the history of tularemia manifestations in the former Buriat-Mongol ASSR (see pp. 22 and 23 supra), Linnik (1957) recorded that the appearance of suspicious attacks among musk-rat hunters in the Severo-Baikalskii Aimak (where these animals had been imported in 1932) in October 1951 led to an investigation, in the course of which 31 persons giving a positive tularin reaction were detected. Out of the 17 persons of this group who gave histories suggestive of past attacks of the disease, one had been ill in 1945, one in 1949, 4 in 1950 and 11 in 1951. Discussing the etiology of the 1951 outbreak, Linnik stated that it was causally related to the hunting of the musk-rats among which a high mortality had been manifest in the autumn of 1951.

As described by Antsiferov and his associates (1957 a), a further tularemia outbreak in the Buriat-Mongol ASSR was observed in 1954-1955 in the Baikalo-Kudarinskii Aimak where breeding of the musk-rats had been started in 1938 and a regular trade in the skins of these animals had been organized under government auspices in 1947. Through investigations made in May 1955 it could be established that an intense tularemia epizootic had been present since the autumn of 1954 in the musk-rat herds of the breeding areas of the aimak, three positive cultures being obtained from carcasses of these animals. An epizootic was evidently also present in the Ungur voles and in Microtus oeconomus living in close contact with the musk-rats. The occurrence of the disease in man could be established with the aid of tularin tests which gave a positive result in 14 out of 29 persons examined. The reactors had suffered from tularemia during the period from July to November 1954, when apparently also a number of people not tested had been affected by the disease. The human infections were invariably due to direct contact with musk-rats and accordingly most of the patients had the bubonic form of the disease.

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1. The former Buriat-Mongol ASSR was recently re-named the Buriat ASSR.

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It is interesting that the epizootics were preceded by the occurrence of drought in 1953 and 1954 which led on the one hand to migrations and concentrations of the musk-rat herds, on the other hand--owing to the absence of floods--to an increased frequency of the small rodents.

There can be no doubt that in this as well as in the other affected regions of the former Buriat-Mongol ASSR the importation of the musk-rats was merely instrumental in making manifest the tularemia infection pre-existent in the local rodent species and in leading to a transition of the disease to man.

#### Chita Oblast

As described by Solodkaia and her associates (1959), tularemia, which had been unknown in the Chita Oblast up to 1955, was detected in June of that year in the Nerchinsk Raion with the aid of agglutination tests made with the sera of two suspicious patients. Investigations made in the village from which these sufferers came, revealed also the presence of two other persons reacting positively in tularin tests. Three of the patients thus detected were found to have suffered from the anginose-bubonic form of tularemia, while one had shown signs of the bubonic form of the disease. Investigations made in the spring of 1956 led to the detection of tularemia in the siskel Citellus undulatus and in the tick Dermacentor nuttalli (see also Ol'khovik et al. 1958, 1959). While assuming that the former was the reservoir of tularemia in the Nerchinsk Raion, the authors expressed the belief that the ticks played an important role in carrying over the infection during the inter-epizootic periods.

Summarizing a report by Kuriatnikova (1958) which was not available in the original, Maksimov (1960) stated that in 1957 in the Borzia Raion of the Chita Oblast

"Tularemia was detected in the tarabagan (Siberian marmot), Microtus gregalis and the tick Dermacentor nuttalli. According to the author (Kuriatnikova), in view of the low frequency of the tarabans and the other rodents, tularemia cannot spread considerably in the area, remaining restricted to separate sections in the form of microfoci. In the absence of epidemiologically dangerous species, such foci often can become manifest only through sporadic human affections."

As stated in a brief note, Ochirov and Pochekunin (1961), making a survey in the Nerchinsk Raion in 1959, failed to demonstrate the presence of tularemia in pooled specimens from 456 rodents of various species and from 240 ticks (Ixodes persulcatus and Dermacentor silvarum), collected from sheep and cattle. However, allergic tests (intracutaneous injection of tularin) gave a positive result in 17 out of the 1,549 inhabitants examined. Most of the positively reacting persons were engaged in trapping muskrats or other rodents or in handling the skins of these animals. 5 of them gave a history suggestive of a past tularemia attacks of the anginose or bubonic form.

#### Khabarovsk Krai

In a paper published in 1958 Shapiro and his colleagues described that in 1956 two patients suffering from the ulcero-bubonic type of tularemia were found in a suburb of the city of Khabarovsk. In order to elucidate the origin of these attacks of the disease, which hitherto appeared to have been absent from the Far-Eastern regions of the Soviet Union, the authors (a) made tularin tests in 285 local inhabitants with histories suggestive of past tularemic affections and (b) examined 219 house-mice, 94 R. norvegicus and 55 field-mice (species not stated). The tularin tests gave a positive result in the case of three persons who evidently had suffered from tularemia in 1954, while evidence of this infection was found in two field-mice. The authors postulated that tularemia was imported into this locality, where an alcohol distillery was placed, by infected grain shipments from the Altai or Western Siberia.

#### Conclusions

Evaluating the evidence adduced above, one may conclude that

1. Tularemia still persists in numerous natural foci situated in various parts of the Soviet Union.
2. A transition of the infection to man can be prevented through the implementation of prophylactic measures, in the first line through wholesale anti-tularemia vaccination.

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To save space and time the following codes, abbreviations and short titles have been used in the bibliography. Except in the cases of known journals, the first reference is given in full and in the original with an appropriate translation. Subsequent references are abbreviated.

### 1. Codes

AMS - Academy of Medical Sciences  
AS - Academy of Sciences  
IME - Institute of Microbiology and Epidemiology  
MH - Ministry of Health  
MI - Medical Institute  
SC - Scientific Conference  
SR - Scientific Research  
SRI - Scientific Research Institute

### 2. Abbreviations and Short Titles

Gig. i san.  
Gigiena i sanitariia  
Gig. i epid.  
Gigiena i epidemiologiia  
Izv. AN Arm SSR  
Izvestiia Akademii nauk Armianskoi SSR Seriiia biologicheskikh  
i sel'sko-khoziaistvennykh nauk.  
Izv. Azovo-Chernomor...  
Izvestiia Azovo-Chernomorskogo instituta mikrobiologii  
i epidemiologii.  
Izv. Irkutsk...  
Izvestiia Irkutskogo nauchno-issledovatel'skogo protivo-  
vochnogo instituta Sibiri i Dal'nego Vostoka.

- Izv. Rostov IME  
Izvestiia Rostovskogo-na-Donu oblastnogo nauchno-issle-  
dovatel'skogo instituta mikrobiologii i epidemiologii.
- Kazan. med. zh.  
Kazan'skii meditsinskii zhurnal.
- Med. parazit.  
Meditsinskaia parazitologiya i parazitarnye bolezni.
- Med. zh. Kazakh.  
Meditsinskii zhurnal Kazakhstana.
- Opyt sov. med. v...voine  
Opyt sovetskoi meditsiny v velikoi otechestvennoi  
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Trudy Permskogo meditsinsko instituta.
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APPENDIX

After completion of the present review three articles appearing in the December 1962 issue of the Zh. mikrobiologii, etc. became available. The consideration of these articles is essential.

- (a) In a well documented contribution dealing with the ecology of tularemia in the Ukrainian forest are Miliutin<sup>1</sup> stated that the presence of the disease was first noted there in the Chernigov Oblast in 1945, while in the Rovensk and Volynsk oblasts to the west attacks began to be noted in 1950. The incidence of tularemia apparently reached an acme in 1955 when in the Rovensk Oblast 73 settlements, each recording 1-7 attacks, were involved. As shown by the prevalence of the ulcerobubonic form, vector-borne infections were most frequent, but attacks due to the consumption of water away from the settlements were also conspicuous.

Miliutin's description of the ecological situation in the area studied by him leaves no room for doubt that the most abundant and amply hunted water-rats were of main epizootological importance. He notes in this connection that during the period from 1957 to 1959 not less than 1.5 million skins of these animals were collected in a single raion of the Rovensk Oblast. However, working from 1955 to 1958, Adamovich and Fel'dman (1960)<sup>2</sup> were successful in obtaining tularemia cultures also from the common voles, Apodemus agrarius and Micromys minutus as well as from ticks (in 12 instances from Dermacentor pictus, once from Ixodes ricinus). Among the diptera the horse-fly Chrysozona pluvialis and Aedes cinereus were apparently the most important vectors of the infection.

Evaluating the situation, Miliutin stated that

"The all-yearly appearing tularemia attacks permit to consider the focus in the Ukrainian Poles'ie as active with large, still not fully elucidated potentialities, and the landscape of the Poles'ie as tularemia-affected. The geographical borders of the natural tularemia foci there are wider than those of the epidemic occurrence of the disease.

Besides the above mentioned vector-borne outbreaks," the author continued, "and also the

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consequences of a contact with contaminated water, there exist in the Ukrainian Poles'ie also the premises for an appearance of other tularemia types--related to agricultural operations and the hunting of water-rats. The numerical prevalence of the common voles on the grain fields, the hunting of hares and the progressive increase of the hunting of water-rats since 1950 render the appearance of these types of real possibility."

- (b) The detection in 1958 of a tularemia focus in a mountainous raion of the Nakhichevan ASSR, situated within the Azerbaidzhan SSR on the Iranian border and not far from the Armenian SSR, has been recorded by Abushev and co-workers.<sup>3</sup> As shown in a table inserted in their article, they succeeded in isolating tularemia cultures from the following animal species:

<u>Species</u>	<u>1958</u>		<u>1959</u>	
	<u>Number</u> <u>Examined</u>	<u>Found</u> <u>Positive</u>	<u>Number</u> <u>Examined</u>	<u>Found</u> <u>Positive</u>
<u>Microtus arvalis</u>	450	13	157	2
<u>Arvicola terrestris</u>	29	3	4	-
<u>Apodemus silvaticus</u>	79	2	27	1
<u>Neomys fodiens</u>	9	2	2	-
Frogs (species?)	14	1	16	-

Evidently the water-rats and common voles M. arvalis), among which after a numerical increase in 1957 a high mortality was present in 1958, were the main hosts of the infection.

Tularin tests made in 78 inhabitants of the affected raion gave a positive result in six. The authors postulated that the past tularemia affection of these persons was the result of a water-borne infection.

- (c) Rendering a comprehensive account of the tularemia situation in the Saratov Oblast, Davidovich and his associates<sup>4</sup> thus recorded the total incidence of the disease and the comparative frequency of its different types up to 1941 and during the quinquennia from 1941 to 1960:



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<u>Period</u>	<u>Total Incidence</u>	<u>Percentage Incidence of the Different Types of Infection</u>				
		<u>Due to Agri- cultural Operations</u>	<u>Domestic</u>	<u>Water- borne</u>	<u>Vector- borne</u>	<u>Due to Water-Rat Hunting</u>
Up to 1941	442	3.8	0.4	19.6	23.5	52.7
1941-1945	14,640	70.3	17.4	10.8	1.2	0.3
1946-1950	1,791	35.8	25.5	13.8	19.5	1.4
1951-1955	36	-	77.7	-	11.1	11.2
1956-1960	4	-	25.0	-	75.0	-

N. B. The information available for the period from 1942 to 1946 was incomplete.

It will thus be noted that up to 1941 tularemia manifestations related to agricultural operations were rare, more than half of the outbreaks being causally connected with the hunting of water-rats, while almost a quarter each were the result of vector- or water-borne infections.

Referring to the period from 1941 to 1946, when tularemia was rampant in the oblast, the authors stated that

"The frequency of small rodents, mainly the common voles, steppe lemmings and house mice during this period in connection with specially favorable climatic conditions and the interruption of all systematic agricultural operations reached 50,000 per hectare. This brought about a spread of the infection from the floodland foci into the whole territory of the oblast.... Thus, for instance, during the period of the epidemic in December 1946 in the steppe raions of the oblast...in which attacks were first noted, 97.5% of the settlements became involved and from 76.5 to 95% of the inhabitants of these raions became affected, i. e. more than 5,000 cases per 10,000 inhabitants. The epidemics observed from 1941 to 1946 were mainly related to agricultural activities (threshing) and only single cases were due to water-rat hunting, contact with diseased water-rats, hamsters and hares, and the bites of blood-sucking insects."

Clinically the manifestations during the war period were characterized by a high frequency (74.2%) of affections of the respiratory organs.

Davidovich and his associates felt convinced that side by side with the modernization of the agricultural operations the wholesale use of anti-tularemia vaccinations was responsible for the spectacular decline of the tularemia incidence since 1951 and the absence of human affections since 1958. Details of the vaccination campaigns commenced in 1946 and extended in 1948 to the whole of the oblast will be furnished in the second part of the present review.

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